THE UNIVERSITY OF MINNESOTA

BULLETIN

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The College of Engineering and the Mechanic Arts

The University Bulletins are issued every six weeks during the University year, at least six numbers every calendar year. Entered at the Postoffice in Minneapolis as second-class mail matter.

MINNEAPOLIS, MINN.

The University Bulletins are published by authority of the Board of Regents, six times a year,—every six weeks during the University year. Bulletins will be sent gratuitously, postage paid, to all persons who apply for them. In calling for bulletins, please state department of the University concerning which you desire information. The full catalogue will be sent only upon receipt of ten cents to pay postage. Address,

THE REGISTRAR,
The University of Minnesota,
Minneapolis, Minn.

The University

THE UNIVERSITY OF MINNESOTA comprises the following named colleges, schools and departments:

THE GRADUATE DEPARTMENT

THE COLLEGE OF SCIENCE, LITERATURE AND THE ARTS

THE SCHOOL OF ANALYTICAL AND APPLIED CHEMISTRY

THE COLLEGE OF ENGINEERING AND THE MECHANIC ARTS

THE SCHOOL OF MINES

THE DEPARTMENT OF AGRICULTURE, including—
- *the College of Agriculture*
- *the School of Agriculture*
- *the Dairy School*
- *the Short Course for Farmers*

THE COLLEGE OF LAW

THE DEPARTMENT OF MEDICINE, including—
- *the College of Medicine and Surgery*
- *the College of Homeopathic Medicine and Surgery*
- *the College of Dentistry*
- *the College of Pharmacy*

The Regents of the University have also entrusted to their charge

THE EXPERIMENT STATION, including—
- *the Main Station at St. Anthony Park*
- *the Sub-Station at Crookston*
- *the Sub-Station at Grand Rapids*

THE GEOLOGICAL AND NATURAL HISTORY SURVEY

THE GRADUATE DEPARTMENT. In each of the colleges, except those of medicine and dentistry, there are advanced courses of study leading to second degrees. These courses are open to graduates of any reputable college upon presentation of diploma.

In the COLLEGE OF SCIENCE, LITERATURE AND THE ARTS, there is a four-years course of study leading to the degree, bachelor of arts. The work of the first year is elective within certain limitations as to the range of subjects from which the electives may be chosen. The remaining work of the course is entirely elective, with the provision that a certain number of long courses be selected. The course is so elastic that it permits the student to make the general scope of the course, classical, scientific or literary, to suit the individual purpose.

THE SCHOOL OF ANALYTICAL AND APPLIED CHEMISTRY, leading to the degrees analytical chemist or chemical technologist offers two courses of study of four years each in analytical and applied chemistry.

A Summer School for Teachers. A six-weeks' course of instruction is offered, in various University subjects, for those whose school duties prevent them from taking the regular University courses

THE COLLEGE OF ENGINEERING AND THE MECHANIC ARTS offers courses of study, of four years each, in civil, mechanical, electrical and municipal engineering leading to the degrees of civil, mechanical, electrical and municipal engineer. This college offers a four-years course of study in science and technology leading to the degree of bachelor of science, with an additional year leading to the engineer's degree in any one of the various lines offered in the college. This college also offers graduate work leading to the degree master of science.

THE SCHOOL OF MINES offers a four-years course of study in mining and metallurgy upon completion of which the degrees, engineer of mines and metallurgical engineer, are conferred.

THE COLLEGE OF AGRICULTURE offers a four-years course in agriculture. The degree of bachelor of science in agriculture is conferred on completion of the course. Students in this college may specialize along the line of forestry or home economics and secure the degree bachelor of sceince (in forestry or in home economics).

THE SCHOOL OF AGRICULTURE offers a three-years course of study and is a training school for practical farm life and in domestic economy. The college of agriculture is open to graduates of this school who have completed the fourth year of work required for admission to the college.

The Dairy School offers practical instruction in dairying to those who are actually engaged in the manufacture of butter and cheese.

The Short Course for Farmers is designed to be of the greatest help possible to those actually engaged in farming.

THE COLLEGE OF LAW offers a three-years course of instruction leading to the degree of bachelor of laws. Graduate work leading to the degrees, master of laws, and doctor of civil law is offered. There is an evening class provided in this college.

THE COLLEGE OF MEDICINE AND SURGERY and THE COLLEGE OF HOMEOPATHIC MEDICINE AND SURGERY offer four-year courses of study of nine months each. Upon completion of either of the prescribed courses the degree, doctor of medicine is conferred.

In the colleges of science, literature and the arts, of medicine and surgery, and homeopathic medicine and surgery, there has been established a combined course of six years leading to the degrees of bachelor of science and doctor of medicine.

THE COLLEGE OF DENTISTRY offers a three-years course of study of nine months each. Upon completion of the prescribed course the degree of doctor of dental surgery is conferred.

THE COLLEGE OF PHARMACY offers a two- or three-years course of study leading to the degree of pharmaceutical chemist. This college also offers graduate work leading to the degrees, master of pharmacy and doctor of pharmacy.

SPECIAL COURSES. In each of the colleges, students of an advanced age and adequate preparation are permitted to pursue, under the direction of the faculty, one or two distinct lines of study.

The University offers no correspondence courses.

The Board of Regents

CYRUS NORTHROP, LL. D., Minneapolis, - - - *Ex-Officio*
The President of the University

The HON. JOHN A. JOHNSON, St. Peter, - - - *Ex-Officio*
The Governor of the State

The HON. JOHN W. OLSEN, Albert Lea, - - - *Ex-Officio*
The State Superintendent of Public Instruction

The HON. JAMES T. WYMAN, Minneapolis, - - - - 1907
President of the Board

The HON. STEPHEN MAHONEY, B. A., Minneapolis, - 1907
Secretary of the Board

The HON. O. C. STRICKLER, M. D., New Ulm - - - 1907

The HON. ELMER E. ADAMS, B. A., Fergus Falls, - 1909

The HON. THOMAS WILSON, St. Paul, - - - - - - 1909

The HON. WILLIAM M. LIGGETT, Benson, - - - - 1909

The HON. A. E. RICE, Willmar, - - - - - - - - - 1909

The HON. EUGENE W. RANDALL, Morris, - - - - 1910

The HON. DANIEL R. NOYES, St. Paul, - - - - - 1910

The HON. GREENLEAF CLARK, LL. D., Died, Dec. 7, 1904

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E. BIRD JOHNSON, B. S., *Registrar*
ERNEST B. PIERCE, B. A., *Assistant Registrar*
B. F. CARTER, *Accountant and Purchasing Agent*

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GEORGE B. FRANKFORTER, PH. D., *Dean of the School of Chemistry*
FREDERICK S. JONES, M. A., *Dean of the College of Engineering and the Mechanic Arts*
WILLIAM R. APPLEBY, M. A., *Dean of the School of Mines*
WILLIAM M. LIGGETT, *Dean and Director of Department of Agriculture*
WILLIAM S. PATTEE, LL. D., *Dean of the College of Law*
PARKS RITCHIE, M. D., *Dean of the College of Medicine and Surgery*
EUGENE L. MANN, M. A., M. D., *Dean of the College of Homeopathic Medicine and Surgery*
WILLIAM P. DICKINSON, D. D. S., *Dean of the College of Dentistry*
FREDERICK J. WULLING, PH. G., *Dean of the College of Pharmacy*

LIBRARIES AND MUSEUMS

WILLIAM WATTS FOLWELL, LL. D., *Librarian*
LETTIE M. CRAFTS, B. L., *Assistant Librarian*
INA FIRKINS, B. L., *Library Assistant*
ANNA L. GUTHRIE, B. A., *Library Assistant*
MARY S. MCINTYRE, B. S., *Librarian of School of Agriculture*
THOMAS G. LEE, M. D., *Librarian of Department of Medicine*
HUGH E. WILLIS, LL. M., *Librarian of the College of Law*
CHRISTOPHER W. HALL, M. A., *Curator Geological Museum*
HENRY F. NACHTRIEB, B. A., *Curator of the Zoological Museum*

ALLEN W. GUILD, *Superintendent of Buildings*
EDWIN A. CUZNER, *Superintendent of Grounds*

CALENDAR FOR 1905-1906

1905 1906

JULY

S.	M.	T.	W.	T.	F.	S.
..	..	..	..	..	..	1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31	..	..	..	..	..

AUGUST

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6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31	..	..
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SEPTEMBER

..	..	..	..	..	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
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OCTOBER

1	2	3	4	5	6	7
8	9	10	11	12	13	14
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NOVEMBER

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12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	..	..
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DECEMBER

..	..	..	..	..	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	..	..	..	..	..	..

JANUARY

S.	M.	T.	W.	T.	F.	S.
..	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	..	..	..
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FEBRUARY

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25	26	27	28	..	..	..
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MARCH

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25	26	27	28	29	30	31
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APRIL

1	2	3	4	5	6	7
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22	23	24	25	26	27	28
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MAY

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20	21	22	23	24	25	26
27	28	29	30	31	..	..
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JUNE

..	..	..	..	..	1	2
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17	18	19	20	21	22	23
24	25	26	27	28	29	30
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University Calendar, 1905-1906

FIRST SEMESTER.

SEPTEMBER	4	M	Examination in English, required of all new students.
	5	T	Entrance examinations and registration.
	6	W	Entrance examinations and registration.
	7	T	Entrance examinations and registration.
	8	F	Entrance examinations and registration.
	9	S	Examinations end and registration completed..... 1 w
	11	M	Classes called for regular work.
	15	F	(First College classes organized, 1869)
	16	S	..... 2 w
	23	S	..... 3 w
	30	S	..... 4 w
OCTOBER	7	S	..... 5 w
	14	S	..... 6 w
	21	S	..... 7 w
	28	S	..... 8 w
NOVEMBER	4	S	..... 9 w
	11	S	.....10 w
	18	S	.....11 w
	25	S	.....12 w
	30	T	Thanksgiving Day. Holiday.
DECEMBER	2	S	.....13 w
	9	S	.....14 w
	16	S	.....15 w
	23	S	Holiday recess begins (no classes).....16 w
	25	M	Christmas day.
JANUARY	1	M	New Year's Day.
	8	T	Work resumed in all departments.
	13	S	.....17 w
	20	S	.....18 w
	22	M	Semester examinations. I and II hour work.
	23	T	Semester examinations. III and IV hour work.
	24	W	Semester examinations. V and VI hour work.
	25	T	Semester examinations. VII and VIII hour work.
	27	S	.....19 w

SECOND SEMESTER.

JANUARY	22	M	Second Semester begins—Classes called for regular work.
FEBRUARY	3	S	..... 1 w
	10	S	..... 2 w
	17	S	..... 3 w
	12	M	Lincoln's Birthday.
	18	S	University Charter, 1868. General Sibley died 1891.....
	22	T	Washington's Birthday.
	24		..... 4 w
MARCH	3	S	..... 5 w
	10	S	..... 6 w
	17	S	..... 7 w
	24	S	..... 8 w
	31	S	..... 9 w
APRIL	7	S	.....10 w
	14	S	.....11 w
	21	S	.....12 w
	28	S	.....13 w
MAY	5	S	.....14 w
	12	S	.....15 w
	19	S	.....16 w
	26	S	.....17 w
	28	M	Semester examinations. I and II hour work.
	29	T	Semester examinations. III and IV hour work.
	30	W	Semester examinations. V and VI hour work.
	31	T	Semester examinations. VII and VIII hour work.
JUNE	2	S	.....18 w

COMMENCEMENT WEEK 1906.

SUNDAY	June 3	Baccalaureate Service.
MONDAY	June 4	Senior Class Exercises.
TUESDAY	June 5	Senior Promenade.
WEDNESDAY	June 6	Alumni Day.
THURSDAY	June 7	Commencement Day—The Thirty-fourth Annual Commencement.
FRIDAY	June 8	Summer Vacation Begins.

PROGRAM OF EXAMINATIONS, SEPTEMBER, 1905.

THE COLLEGE OF SCIENCE, LITERATURE AND THE ARTS.
THE COLLEGE OF ENGINEERING AND THE MECHANIC ARTS.
THE SCHOOL OF MINES.
THE COLLEGE OF LAW.
THE SCHOOL OF CHEMISTRY.

The number placed after the subjects, when given, indicates the room in which the examinations will be held.

Day	Hour	Subjects for admission to the freshman class.
Monday, September 3,	9:00 a. m.	English—required of all.
Tuesday, September 4,	8:00–10:30	*Elementary Algebra.
	10:45– 1:15	*Higher Algebra.
	2:30– 5:00	*Plane Geometry.
Wednesday, September 5,	8:00–10:30	*Solid Geometry.
	10:45– 1:15	†All History Subjects.....17
	2:30– 5:00	†Civics.....16
Thursday, September 6,	8:00–10:30	†Political Economy.....16
		*German.
		*French.
	10:45– 1:15	*Latin Grammar.
	2:30– 5:00	*Greek.
		*Cæsar.
Friday, September 7,	8:00–10:30	*Cicero.
		*Vergil.
	10:45– 1:15	§Chemistry.....
		**Physics.....
	2:30– 5:00	‡Botany.....29
		‡Zoology.....35
		*Astronomy..... B
Saturday, September 8,	8:00–10:00	‡Geology.....18
	10:45– 1:15	¶Physiography.....18
		¶Drawing.....24
		¶Shop Work.....

*Place to be announced; †Library Building; ‡Pillsbury Hall; §Chemical Laboratory; **Armory; ¶The Shops.

Equipment

GROUNDS AND BUILDINGS.

The University campus comprises about forty-five acres lying between University avenue and the river and between Eleventh and Nineteenth avenues Southeast. The campus is well wooded with a fine growth of native oaks and commands a beautiful view of St. Anthony Falls and the city, but are sufficiently removed from the business center of the city to insure desirable quiet and retirement. The buildings upon the campus number twenty, and are valued at over $800,000. A special clinical building for the use of the department of medicine is located in the southern part of the city, where there is an abundance of clinical material, and within easy reach of the University. The campus is valued at about $450,000 and the equipment of the buildings at about $300,000.

The State Experimental Farm, upon which are located the buildings of the experiment station and the department of agriculture, consist of over two hundred and fifty acres of very valuable land half way between the twin cities and within a thirty-minutes' ride of either city. The farm is valued at $400,000, and the sub-stations located at Crookston and Grand Rapids, at $30,000 more. The buildings and equipment of the department of agriculture are valued at over $400,000.

LIBRARIES.

The following libraries are easily accessible to the University students:

Minneapolis—The University Libraries, 110,000 volumes; the Public Library, 125,000 volumes; the Minneapolis Bar Association, the Guaranty Loan Law, and the New York Life Insurance Law Libraries, numbering a total of about 30,000 volumes, are open under certain restrictions to law students; the Minnesota Academy of Natural Sciences, 7,000 titles.

St. Paul—The State Historical Library, 70,000 volumes; the State Library, 35,000 volumes; Public Library, 55,000 volumes.

The University Library consists of:

1. **The General Library.**

2. **College Libraries,** including Law, Medicine, Engineering, Agriculture.

3. **Departmental Libraries,** including Art, Astronomy, Biology, Botany, Chemistry, French, Geology, German, Greek and Latin, History, Military Science, Pedagogy, Physics, Rhetoric, Scandinavian.

The private collections of professors are available when necessary for research.

The whole number of bound volumes owned by the University is about 115,000. Unbound books and pamphlets, about 30,000. About 500 current periodicals are received in the general and other libraries.

The departmental libraries consist mainly of books of reference and current periodicals relating to technical subjects.

The general library is open to students and the public from 8:00 a. m. to 9:30 p. m., every day of the University year, except Sundays and legal holidays.

The Law Library contains nearly all the English Reports, including those of Canada, from the earliest decisions down to the year 1900; nearly all the reports of the different states of the Union; all the reports of the United States Supreme Court, and all the Federal Court reports. It contains also the digests of these reports and an excellent selection of standard textbooks and law dictionaries.

The Nelson Law Library is a rare collection of fifteen hundred volumes, donated to the University by the Honorable R. R. Nelson, of St. Paul, upon retirement from the Federal bench. It contains many old English reports, in addition to those already mentioned, and many ancient treatises upon common law.

A rare and unique addition to the Law Library has been secured by the donation of Judge Collins and former Attorney-General Childs turning over to the University all the Briefs and Paper-Books in the causes argued in the Supreme Court of Minnesota since 1888, making a fine collection of over five hundred bound volumes.

The Medical Library contains a large and well assorted collection of books, sets of journals, bound and unbound pamphlets, relating to all branches of medicine. All of the leading

medical journals are on file in the reading room. The various laboratories have also reference libraries devoted to their special lines of work.

The library was greatly enriched by the bequest of the late Dean, Perry H. Millard, M. D., who bequeathed his entire private medical library to the department. This collection consists of several hundred volumes and pamphlets, including many rare and old medical works, sets of journals especially rich in surgical works.

To all these library facilities may be added the Minneapolis Public Library, which is within easy reach of the University and is opened freely to the students of the University. This library contains over one hundred twenty-five thousand bound volumes and over fourteen hundred of the leading newspapers, magazines and periodicals of the world.

MUSEUMS.

The museums of the University contain material obtained from various sources arranged with special reference to its use for illustration. Among the more notable collections are the following:

(a) **In Geology and Mineralogy**: The Kunz collection of minerals, purchased of George F. Kunz; several suites of crystalline rocks secured from various sources; the Ward collection of casts contributed in part by citizens of Minneapolis; collections of the rocks, fossils, minerals and economic products of Minnesota; upwards of 9,000 entries gathered by the geological survey of the State; the Sardeson collection of paleozoic fossils of Minnesota, Wisconsin, Iowa and neighboring states, comprising 4,500 entries and more than 30,000 specimens; a series of thin sections of typical rocks and minerals largely representing Minnesota localities; purchased material comprising a fine collection of crystals; 5,000 minerals and 3,000 specimens of economic minerals and crystalline rocks.

(b) **In Zoology**: All the material collected by the State Zoologist; a collection of mounted Minnesota birds representing about one-third of the species found in the State; a number of the mammals of the State and a few from the more western states; a collection of fishes, molluscan shells, corals and other foreign material.

The ornithological room contains the excellent Thomas S. Roberts and Franklin Benner collection of skins, nests and eggs of Minnesota birds. Other groups of animals are more or less

numerously represented, and are receiving annual additions from the Zoological Survey.

(c) **In Botany:** The general herbarium numbering about 250,000 specimens and comprising the series of plants collected by the State Botanist; an alcoholic collection of material for dissection; a collection of woods of Minnesota; a limited series of carboniferous and cretaceous fossil plants, including the Lesquereaux collection from the Minnesota River localities.

(d) **The Museum of Technology:** A cabinet of specimens illustrating the products and processes of applied chemistry is being collected by the professor of chemistry, as opportunity offers. The collection embraces fuel, ores, furnace products, textile materials, both raw and manufactured, dyewoods and other materials used in dyeing; specimens illlustrating the bleaching and printing of cotton, linen and woolen goods, earthenware, pottery, etc.

(e) **The Classical Museum:** Some material illustrating classical geography, topography, chronology, mythology, archaeology, and art has been collected, consisting mainly of plans and charts, casts, pictorial illustrations, fac-similes of manuscripts and inscriptions.

(f) **In English:** A few fac-similes of manuscripts, plates that may serve for the purpose of archaeological instruction, publication of texts, reprints of blackletter books and of original editions, photographs and portraits have been gathered.

(g) **Civil Engineering:** The department is collecting samples of road material typical of the various localities of the State; leading materials used in street paving, such as granite, trap rock, brick and asphaltum. A set of standard sections of steel and wrought iron is provided for illustration in the study of structural design.

(h) **Mechanical Engineering:** The collection consists of models of mechanical motions especially relating to the work in kinematics; sectioned apparatus, such as injectors, water meters and steam separators; various collections of drop forgings in iron, steel and copper; miscellaneous samples of commercial work representing the product of special machines; groups of standard nuts, bolts and screws; samples of belting, ropes, steel and iron cables, rawhide gears, and other material especially useful for illustrative purposes.

(i) **Electrical Engineering Museum:** This museum contains a growing collection of samples furnished by various man-

ufacturers and dealers for demonstrating the merits of different products and for illustrating modern practice; an excellent collection showing the development of electrical instruments, lightning arresters, switches, primary and secondary batteries, early forms of dynamos and motors, lighting apparatus and various industrial applications of electricity; also a collection of samples from repair shops and elsewhere, illlustrating the effects of wear, accidents and abuse.

ASTRONOMICAL OBSERVATORY.

The students' astronomical observatory contains a ten and one-half inch combined, visual, photographic and spectroscopic refracting telescope, constructed by Warner Swasey and Brashear; a photographic measuring machine by Repsold; a spectrometer by Brashear; a three inch transit circle and chronograph by Fauth; a Howard astronomical clock.

GYMNASIUM.

The gymnasium is located in the Armory, and is well equipped with a variety of gymnastic appliances. The object of the gymnasium is to provide all of the students of the University opportunity for exercise to build up their general health. It also provides special training to correct physical defects and functional derangements. The gymnasium is in charge of a professional medical director and assistant and the training is under their direct supervision. A thorough physical examination is offered each student immediately before and after the gymnasium course, a record is made of the same. The examination of these records shows a marked improvement in the standard of health of the average student during his college course. The gymnasium is open at all times to all young men in the University who are free to use the apparatus and to pursue a course of physical training under the direct supervision of the director and his assistant. In some of the colleges of the University, this work is required of all men.

General Information.

THE UNIVERSITY YEAR.

The University year covers a period of thirty-eight weeks beginning on the Tuesday before the first Thursday in September. Commencement day being always the first Thursday in June.

THE ONE MILE LIQUOR LAW.

A state law provides that "it shall be unlawful for any person to sell or dispose of any spirituous, vinous, or malt liquors within the distance of one mile of the main building of the University of Minnesota, as now located in the city of Minneapolis; provided, that the provisions of this section shall not apply to that part of the city of Minneapolis lying on the west side of the Mississippi River."

STUDENTS' SOCIETIES.

RELIGIOUS.

The Students' Christian Association was organized in 1869; its object being to promote growth in Christian character, and to engage in such religious work as may be deemed expedient and necessary.

The Association owns a commodious building, which serves as the headquarters for student religious activity. All persons in sympathy with the object of the association are eligible to membership.

The Young Men's Christian Association has as its object the promotion of "growth in grace and Christian fellowship among its members and aggressive Christian work, by and for students." This associations leases the Students' Christian Association building and keeps it constantly open, with a general secretary in charge. All men in sympathy with the object of the association are eligible to membership. This building is maintained as the social and religious headquarters of all young men in the University.

This Association also provides an employment bureau whose services are free to students in all departments of the institution, as well as a committee to help students to find comfortable rooms and boarding places. The Association also maintains an educational department in which students may make up their entrance conditions without any charge for instruction.

The general secretary will be pleased to correspond with any young man intending to come to the University. Address the General Secretary of the Young Men's Christian Association, University of Minnesota, Minneapolis, Minn.

The Young Women's Christian Association is the center of Christian life among the young women of the University. Its object is "To deepen spiritual thought in the University woman, to environ her with a semblance of home, to bring to her friendship, assistance and sociability by stimulating student fellowship, to give her personal help when necessary; thus developing in her the Christ ideal of culture in womanhood."

To this end frequent socials and informal teas are given throughout the year; twice each week twenty minute prayer meetings are held, a dozen circles meet one hour a week for devotional Bible study; and from time to time missionary meetings are held. The general secretary devotes all of her time to the association and will be pleased to correspond with any young woman who wishes information regarding the University.

All young women are invited to visit the Young Women's Christian Association room before registering. A group of upper classmen will be there during the opening days to give advice and assistance.

THE UNIVERSITY CATHOLIC ASSOCIATION.

The University Catholic Association was organized by the Catholic students in the spring of 1900. The purpose of the association is the study of the Bible and of the doctrines and history of the Catholic church. Membership is open to any one connected with the University. Regular meetings are held every Sunday afternoon in the rooms of either the Young Men's or of the Young Women's Christian Association, through the courtesy of those organizations. The association is planning to erect a building on or near the campus at an early date.

Aside from the religious objects, the association tends to promote good fellowship among its members. Early in each University year a reception is tendered to new students and during the year two or more socials are held.

Further information may be obtained by addressing the secretary of the association at the University.

LITERARY, SCIENTIFIC AND PHILOSOPHICAL.

Literary Societies—The literary societies are mainly debating clubs. Every student is welcome to attend the literary sessions, but the business sessions are usually held behind closed doors. Students desiring to join should make early application to some member of the society he prefers, as the membership is limited.

The Minnesota Literary Union—Is a federation of the members of the following societies: Shakopean, Forum, Castalian, Minerva, Hermean and Arena. Four meetings are held each year.

Shakopean—Membership limit, 35; men: **Forum**—Membership limit, 30; men: **Minerva**—Membership limit, 30; women: **Law Literary**—Unlimited; law students: **Castalian**—Membership limit, 35; men: **Kent**—Membership limit, 30; law students: **Theta Epsilon**—Membership limit, 30; women: **Thalian**—Membership limit, 25; women: **Arena**—Membership limit, 30; men: **Society for Legal Culture**—Membership limit, 30; men.

The Philological Society—The object of the philological society is to promote philological investigation and study.

Greek Club—Is a society organized by professors, students and alumni of the department of Greek for the study of Greek life, language and customs.

Societas Latina is a society in the department of Latin, having for its special aim the securing of greater proficiency in reading and writing Latin.

The Graduate Club is a club organized for the purpose of fostering a greater interest in graduate work, for mutual help, and for the discussion of topics under investigation.

The Dramatic Club is organized for the study and practice of dramatic art. One or more plays are put on the stage each year.

The Society of Engineers meets once in two weeks to listen to addresses by prominent engineers and for the discussion of various engineering topics.

The Geological Club is an organization of instructors and students interested in geology, for the discussion of geological problems.

The Scandinavian Literary Club is an organization whose purpose is to promote interest in the study of Scandinavian literatures.

The Federated Debating Board has charge of home and inter-collegiate oratorical contests.

The Economic Club meets twice a month for debate in economic and political subjects.

The Mining Society is an organization of mining engineering students who meet for the purpose of hearing lectures and discussing mining engineering problems.

The Camera Club is an organization of instructors and students interested in photography and photographic chemistry.

The Botanical Students' Journal Club is an organization of juniors, seniors and graduate students, of the department of botany, for the review of current botanical literature.

The Zoological Journal Club for instructors and advanced students who meet for the discussion of current zoological literature.

The University Liberal Association is an organization of students and faculty members formed for the discussion of topics of broad and current interest. It meets twice a month, usually on Saturday evening.

The Zoological Reading Club is for instructors and graduate students. Its purpose is the reading and discussion of philosophical works on Zoology.

The Physical Colloquium is composed of instructors and graduate students and meets for the discussion of recent investigations in physical science.

The Glee and Mandolin Clubs give a public concert each year at the University and make a tour of the state during the holidays.

The University Band is organized as a part of the military system of the University and furnishes music for many University affairs.

Women's League is an organization of the women of the University for mutual helpfulness and sociability. The league is planning to erect a woman's building upon the campus and have already raised considerable money for this purpose.

The Northern Oratorical League is composed of the orator-

ical associations of the University of Michigan, Northwestern University, the University of Wisconsin, Oberlin College, the State University of Iowa, the University of Chicago, and the University of Minnesota. Its purpose is to foster an interest in public speaking and to elevate the standard of oratory by holding annual contests. The contests are open only to undergraduates.

The Central Debating League is composed of the debating associations of the University of Michigan, the University of Minnesota, Northwestern University, and the University of Chicago. Its purpose is to discuss in public leading questions of the day and in this way to develop ready and forceful speakers.

The four universities are arranged in two groups for the semi-final debates, which are held the second Tuesday in January. On the first Friday in April in each year, the winners from the groups meet in a final debate in the city of Chicago.

The University has been admitted to compete for the **Hamilton Club** competition. Michigan, Minnesota, Wisconsin, Iowa, Ohio, Indiana, Northwestern and Chicago Universities constitute the league. Each of the colleges named submits one oration upon Alexander Hamilton or some character or event connected with his time. From the orations submitted four are chosen to be delivered before the Hamilton Club.

ATHLETICS.

The Athletic Association is an organization having for its object the general physical well-being of the students and the encouragement of a proper spirit in favor of hearty, manly sports.

Control of Athletics. The athletic sports of the University are under the supervision of a Board of Control made up of eleven members; two are members of the faculty, two are alumni and seven are students. This board has general supervision of all matters connected with athletic contests: they pass upon the eligibility of players, investigate charges of misconduct and arrange the schedule of games. It is the purpose of this board to foster a spirit in favor of fairness and honesty in all atheltic contests.

Northrop Field is an enclosed athletic field containing about six acres, immediately adjoining the armory. It is surrounded by a high brick wall and is one of the finest athletic fields in the country.

SCHOLARSHIPS.

It is the policy of the University to establish scholarships in the different departments, where extra help is needed for instruction, under regulations somewhat as follows:

1. The appointments are made by the executive committee of the Board of Regents, upon the recommendation of the department in which the appointment is desired, after approval by the general faculty.
2. Recipients of scholarships may be either graduate or undergraduate students.
3. The scholarships are not intended as gifts or benefactions from the state to the recipients, but as provisions under which services may be rendered the University.
4. It is understood that these services are of a nature which shall assist the holder of a scholarship to attain the mastery of some line of work in the department to which he is appointed.

PRIZES.

THE PILLSBURY PRIZE.

Three prizes of $100, $50 and $25, offered by the heirs of the Hon. John S. Pillsbury, are awarded for the best work in the rhetorical department, as evidenced finally by an oration in public.

THE '89 MEMORIAL PRIZE IN HISTORY.

The class of 1889, at graduation, established a prize of $25 each year, to be known as the '89 Memorial Prize, and to be given for the best thesis in history. The award is made by a professor of history in some other institution.

THE MOSES MARSTON SCHOLARSHIP IN ENGLISH.

Friends and pupils of the late Professor Marston, Ph. D., have given and pledged one thousand dollars as a memorial fund. The annual income of the fund is to be used to help some student in the long English course. The award of the income is made on the basis of pecuniary need and of deserving scholarship.

THE ALBERT HOWARD SCHOLARSHIP FUND.

Under the last will and testament of Mr. James T. Howard, of the town of St. Johnsbury, Vermont, $4,166.81 was left to

the University to establish a scholarship to be known as the "Albert Howard Scholarship." This scholarship is assigned by the executive committee upon the recommendation of the general faculty.

THE SCHURMEIER PRIZE.

Hon. Theodore L. Schurmeier, of St. Paul, offers through the department of Sociology, a prize of twenty dollars for the best essay presented by an undergraduate student on the subject of "The Social Forces in the Making of Emerson."

THE WILLIAM JENNINGS BRYAN PRIZE.

The Hon. William Jennings Bryan has given the University the sum of $250.00 for the encouragement of studies in political science. The annual income will be given as a prize to the writer of the best essay upon a topic to be announced each year. The competition is open to all students of the college of science, literature and the arts.

THE BRIGGS' PRIZE IN FOUNDRY PRACTICE.

For the encouragement of studies in foundry practice, Mr. O. P. Briggs, commissioner of the National Foundrymen's Association, Detroit, Mich., offers $75 annually, in two prizes, which are to be accompanied by gold medals. The competition is open to sophomores in the college of engineering, and the prize will be awarded for the best essay relative to the above subject. No prize will be awarded if less than five essays are submitted in competition.

THE DUNWOODY PRIZE.

Mr. William H. Dunwoody, president of the St. Anthony and Dakota Elevator Company, has provided a cash prize of $75 for the members of the team winning the inter-sophomore debate, and another prize of $25 for the student in the sophomore class writing and delivering the best oration.

THE LOWDEN PRIZE.

Mr. Frank O. Lowden, of Chicago, offers as a prize to be competed for by the Northern Oratorical League, an endowment of $3,000, which will yield an annual income of about $175. A prize of $100 will be given to the winner of the first place, $50 to the orator who gets second place, and the remainder will be set aside each year for an interest fund to accumulate, and, in time, produce another endowment.

THE PEAVEY PRIZE.

Mrs. Heffelfinger continues the prize of $100, established by her father, the late Frank H. Peavey. This prize consists of $75 for the members of the team winning the freshman-sophomore debate, and another prize of $25 to the student in the freshman or sophomore class writing and delivering the best oration.

SPECIAL PRIZES IN ORATORY AND DEBATE.

The Department of Rhetoric has been enabled to offer, through the generosity of friends of the University, numerous cash prizes, amounting in all to three hundred and eighty-five dollars. This in addition to the regular annual prizes offered for special excellence of work in that department. The names of the donors and the amounts contributed by each, follow: George H. Partridge, '79, $100; Charles S. Pillsbury, '00, $75; John S. Pillsbury, '00, $75; Edward Backus, $40; C. A. Smith, $25; The H. W. Wilson Company, $25; Fred Snyder, '81, $10; D. P. Jones, '83, $10; Asa Payne, $10; H. B. Avery, '93, $5; Russell Spicer, '97, $5; Christopher Graham, '87, $5.

THE WYMAN PRIZE.

A prize of twenty-five dollars is offered by the Honorable James T. Wyman, of Minneapolis, through the department of political science, for the best essay of three to five thousand words by an undergraduate student, on the subject of "The Labor Question in Farming Communities."

THE ELLIOT SCHOLARSHIP LOAN FUND.

To fulfill the wish of the late Dr. A. F. Elliot to aid young men who find their efforts to obtain a practical education embarrassed through lack of means, the income of $5,000, amounting to $250 per year, is placed in the hands of the Board of Regents to be used as a scholarship loan fund for assisting young men in the school of mines.

The conditions of granting the scholarship loans are: The financial needs of the applicant, his scholarship, moral character, enthusiasm shown in his work and promise of usefulness in his profession. When money is available it may be loaned to pay expenses of worthy students during sickness. The loans

are to be repaid, without interest, at the earliest convenience of the recipients.

THE GILFILLAN TRUST FUND.

The Honorable John B. Gilfillan has given to the University the sum of fifty thousand dollars, yielding an annual income of twenty-five hundred dollars, to be used by the Board of Regents to assist worthy students, needing such aid, to secure an education. The Regents are empowered to give this aid in the way of loans or gifts, according to the circumstances of the case. As a rule the fund is used as a loan fund, and a small rate of interest is charged. The details of the regulations which have been adopted by the Regents for the administration of the fund may be learned by addressing the President of the University.

PUBLICATIONS.

The University Bulletins are published by authority of the board of Regents twelve times a year—every four weeks during the University year. Bulletins will be sent gratuitously, postage paid, to all persons who apply for them.

The Minnesota Alumni Weekly is published every Monday during the University year. The Weekly is published entirely in the interest of the alumni and is devoted to alumni news and such University news as may be of special interest to the alumni.

The Minnesota Daily is published five times each week during the University year by an organization of University students.

The Junior Annual, called the "Gopher," is a book published annually by the junior class of the University.

The Minnesota Magazine is a monthly magazine devoted to the cultivation of literary taste and effort among the students of the University. It is managed by a board of editors chosen from the senior class.

The Year Book of the Society of Engineers. The book is published yearly by the students of the engineers' society. It is devoted to the publication of articles upon engineering subjects by professors and students in the college of engineering and the mechanic arts.

EXPENSES OF YOUNG MEN.

At the request of University officials, in past years, a considerable number of students have kept strict accounts of their expenses, and the following statement shows fairly the possibilities as to expenses for a year's work at the University.

Class and society dues	$ 6.00	$ 8.25	
Room rent (9 months)	36.25		
Board (39 weeks)	85.05	208.75	$ 175.00
Laundry	9.95		
Books and stationery	13.95	32.51	30.00
Street car fare	3.80	4.95	
Clothing	20.80	74.25	50.00
Benevolence, including amusements	17.35	24.90	
Railroad fare		16.25	30.00
Miscellaneous	24.35	27.23	
Total expenses	$ 217.50	$ 397.09	$ 285.00
Saved during summer	$ 35.00		
Earned during the year	237.75	272.09	265.00
	272.75		
Expenses	217.50		
Balance, over expenses	$ 55.25		
Balance		$ 125.00	$ 20.00

This table does not represent the fees to be paid by students, and students who are planning to attend the University should take that into account.

The students represented in the above statements are fairly representative; they were neither extravagant nor did they deny themselves unduly to get along.

The student who learns some trade before coming to the University has a great advantage over the student who has to earn his money by ordinary manual labor. Students have earned their whole expenses while attending the University, and have made good records at the same time. Other students have done so much work that they have not been able to keep up their studies, and have thus missed the one thing for which they were attending the University.

If it is possible for the student to have a part of his expenses paid, he should not attempt to earn his way entirely by his own exertions. It is a comparatively easy thing for a young man to earn half his living while attending the University and yet do good work in his classes. Students who want work seldom fail to find it. In coming to the University, the student should bring enough money with him so that he can

live comfortably for a few weeks until he can find something to do.

EXPENSES OF YOUNG WOMEN.

Rent	$ 75.21	$ 40.75	$ 58.00
Board, light, laundry		52.42	138.00
Fuel		7.25	
Railroad fare and cartage	9.32	27.80	30.22
Street car fare		5.85	6.00
Stationery	2.16	8.97	
Amusements and membership dues	7.50	10.56	20.19
Personals and clothing	32.63	72.51	67.59
Books, fees and incidentals	23.26	18.94	35.60
Totals	$ 150.08	$ 240.05	$ 355.60

A pamphlet has been published containing five papers (one by a young woman), relating actual experience of students who have made their way through the University.

Students who contemplate making their way through college will find here stated the stern and unpleasant side, as well as the brighter side of such a life. A copy will be sent free to any address upon application.

The College of Engineering and the Mechanic Arts.

FACULTY

CYRUS NORTHROP, LL. D., *President.*
FREDERICK S. JONES, M. A., *Dean.*

OFFICERS OF THE DEPARTMENT OF CIVIL ENGINEERING.

WILLIAM R. HOAG, C. E., *Professor of Civil Engineering, in charge of Road and Topographical Engineering.*
FRANK H. CONSTANT, C. E., *Professor of Structural Engineering.*
FREDERICK H. BASS, C. E., *Assistant Professor of Civil Engineering, in charge of Municipal and Sanitary Engineering.*

OFFICERS OF THE DEPARTMENT OF MECHANICAL ENGINEERING.

JOHN J. FLATHER, Ph. B., M. M. E., *Professor of Mechanical Engineering.*
WILLIAM H. KAVANAUGH, M. E., *Assistant Professor of Mechanical Engineering, in charge of Experimental Engineering.*
EDD C. OLIVER, M. E., *Instructor in Machine Design.*
ROY S. KING, M. E., *Instructor in Mechanical Engineering.*
WILLIAM H. MERRIMAN, *Instructor in Machine Work.*
JAMES M. TATE, *Instructor in Carpentry and Pattern Work.*
EDWARD JOHNSON, *Instructor in Foundry Practice.*
HENRY ULRICH, *Assistant in Carpentry.*
PETER JOHNSON, *Machinist.*
GEO. P. MUNGER, *Assistant in Forge Work.*
HARRY W. DIXON, *Chief Engineer.*
ROBERT WHERLAND, *Assistant Engineer.*

OFFICERS OF THE DEPARTMENT OF ELECTRICAL ENGINEERING.

GEORGE D. SHEPARDSON, A. M., M. E., *Professor of Electrical Engineering.*
FRANK W. SPRINGER, E. E., *Assistant Professor of Electrical Engineering.*

OFFICERS OF THE DEPARTMENTS OF ENGINEERING AND MECHANICS, AND MATHEMATICS.

HENRY T. EDDY, C. E., Ph. D., LL. D., *Professor of Engineering and Mechanics.*
ARTHUR EDWIN HAYNES, M. S., M. Ph., Sc. D., *Professor of Engineering Mathematics.*
WILLIAM E. BROOKE, B. C. E., M. A., *Instructor in Engineering Mathematics.*
ARTHUR C. RINGSRED, *Student Assistant in Engineering Mathematics.*

OFFICERS OF THE DEPARTMENT OF PHYSICS.

FREDERICK S. JONES, M. A., *Professor of Physics.*
JOHN ZELENY, B. S., B. A., *Associate Professor of Physics.*
ANTHONY ZELENY, M. S., *Instructor in Physics.*
HENRY A. ERIKSON, B. E. E., *Instructor in Physics.*

OFFICERS OF THE DEPARTMENT OF CHEMISTRY.

GEORGE B. FRANKFORTER, M. A., Ph. D., *Professor of Chemistry.*
CHARLES F. SIDENER, B. S., *Assistant Professor of Chemistry.*
EDWARD E. NICHOLSON, M. A., *Assistant Professor of Chemistry.*

OFFICERS OF THE DEPARTMENT OF DRAWING.

WILLIAM H. KIRCHNER, B. S., *Assistant Professor of Drawing.*
JOHN H. QUENSE, C. E., M. E., *Instructor in Drawing.*
FRANKLIN R. MCMILLAN, *Student Assistant in Drawing.*

OFFICERS OF THE DEPARTMENT OF POLITICAL SCIENCE.

WILLIAM W. FOLWELL, LL. D., *Professor of Political Science.*
WILLIAM A. SCHAPER, Ph. D., *Assistant Professor of Political Science.*

OTHER DEPARTMENTS GIVING INSTRUCTION.

FREDERICK W. SARDESON, Ph. D., *Instructor in Geology.*
EDWARD P. SANFORD, M. A., *Instructor in English.*
GEORGE H. MORGAN, MAJOR, U. S. A., *Professor of Military Science.*
FRANCIS P. LEAVENWORTH, M. A., *Professor of Astronomy.*
WILLIAM S. PATTEE, LL. D., *Lecturer on Contracts.*

STANDING COMMITTEES.

Enrollment—PROFESSORS CONSTANT, FLATHER, SPRINGER.
Curriculum—PROFESSORS EDDY, FLATHER, HOAG, JONES, SHEPARDSON.
Degrees—DEAN JONES, PROFESSORS FLATHER, SHEPARDSON, HOAG.
Library—PROFESSORS SPRINGER, CONSTANT, KAVANAUGH.
Military Affairs and Athletics—PROFESSORS HOAG, HAYNES, NICHOLSON.
Students' Work—PROFESSORS HAYNES, KIRCHNER, HOAG, SHEPARDSON, KAVANAUGH, BROOKE, JONES.
Graduate Studies and Degrees—PROFESSOR EDDY.
Program—PROFESSORS KIRCHNER AND BASS.

NON-RESIDENT LECTURES.

Electrical engineering department, University of Minnesota, 1904-1905.

Edward P. Burch, consulting engineer, Minneapolis, "Speed-torque Characteristics of Steam and Electric Locomotives."

Lee M. Coleman, electrical contractor, Minneapolis, "Experiences of An Installing Engineer."

Jake Danner, telephone engineer, Western Electric Company, Chicago, "Telephone Cables."

Chas. E. Downton, foreman of apprentices, Westinghouse Electric and Manufacturing Company, Pittsburg, "The Training of Engineering Apprentices in An Electrical Manufacturing Plant."

Locke Etheridge, district engineer, Stanley Electric Manufacturing Company, Chicago, "The Engineer Salesman."

Truman Hibbard, chief engineer, Electric Machinery Company, Minneapolis, "Commercial Features of Dynamo Design."

Chas. L. Pillsbury, consulting engineer, St. Paul, "Design and Construction of the Municipal Electric Lighting Plant at New Ulm."

ORGANIZATION OF THE COLLEGE.

In this college there are four regular courses of study, viz.: civil, mechanical, electrical and municipal engineering, leading to corresponding professional degrees.

There is also organized in this college a four years' course of study in science and technology, leading to the degree of bachelor of science, with an additional year leading to the professional degree.

UNCLASSED STUDENTS.

Unclassed students are permitted to pursue, under the direction of the faculty, one or two lines of study, selected from some regular course. Such students must be persons of mature years, and present preparation sufficient to admit them to the freshman class. Persons of mature years, who shall give satisfactory evidence of ability to do with credit the work applied for, may be admitted by vote of the faculty.

FEES.

A registration fee of fifteen dollars per semester, payable in advance, is required of all residents of the state who regis-

ter in this college. Non-residents are charged double this fee, or thirty dollars per semester. No reduction is made for late entrance or for leaving before the end of the semester. In addition to this fee students who take laboratory work are charged a sum sufficient to cover the cost of material and breakage. The fees are as follows: **Freshman year** (per semester)—Shop work, $7; chemistry, $5. **Sophomore year** (per semester)—Shop work, $7; physics, $3; chemistry, $3, first semester only. **Junior year**—Shop work, $4.50; mechanical laboratory, first semester, $6; second semester, $3; electrical laboratory, second semester, $4.50. **Senior year**—Electrical laboratory, both semesters, $3 or $6; mechanical laboratory, first semester, $4.50 E. E.; $6 M. E.; second semester, $6.

ADVANCED STANDING.

Advanced standing—The University accepts records from all reputable colleges for credit to advanced standing. Such records are accepted as far as they are equivalent to the work done in this University, subject to the approval of the departments concerned. In bringing records from other institutions, the certificate must be on the official blanks of the institution granting the certificate, and should show:

1. The subject studied and ground covered.
2. The time spent upon each subject.
3. In case of laboratory subjects a concise statement of work done.
4. The result—it is sufficient to state that the subject was creditably completed.

The credit to be allowed will be decided in individual cases by the enrollment committee in consultation with the departments concerned.

GRADUATION.

Students completing the course of study to the satisfaction of the faculty of the college, are entitled to receive the professional degree. Any person may undergo, at suitable times, examination in any subject, and if such person pass in all the studies and exercises of the course, he is entitled to the appropriate degree; **provided,** however, that at least one full year must be spent at the University, before such degree shall be granted, and **provided,** the examination, in every case, be held before a committee of the faculty appointed for that purpose.

ADMISSION.

Entrance examinations are held only at the beginning of the college year. Students prevented from entering at the beginning of the year may be admitted at a subsequent date when the circumstances are such as to justify the action. However, such students are at a great disadvantage and all students expecting to enter the University are urged to be present at the beginning of the year.

All applicants should present themselves to the registrar, who will furnish them with application blanks and directions how to proceed with their examinations and registration.

In all cases the faculty reserves the right to require a student to take supplementary examinations if he does not sustain himself creditably in his course.

REQUIREMENTS FOR ADMISSION.

N. B.—Students proposing to enter this college should be specially thorough in their mathematical preparation, since the prosecution of the work of the course depends so largely upon the preliminary work done in this line. In order to gain admission to this college, the applicant shall present State High School Board certificates for each of the mathematical subjects required for admission; or, in lieu thereof, take the entrance examinations in the said subjects.

It is further provided that no student shall be admitted, who fails to obtain credit in all of the mathematical subjects required for admission to this college.

ENTRANCE ENGLISH.

Every person admitted to the University is examined in reading, writing, spelling and composing the English language, and all who fail to obtain a grade of seventy-five per cent are required to pursue a course of instruction to be provided, and no person shall ever receive a diploma or other certificate of merit or proficiency until he has passed such examination and obtained the specified credit. See Appendix "A."

N. B.—Time element, specified with each subject, is essential.

English, four years, including

(a) Classics. (b) Principles of composition.

(c) Practice in written expression.

Algebra, elementary, one year, **Algebra,** higher, one-half year.

Geometry, plane, one year. **Geometry,** solid, one-half year.

Chemistry, one year.

In addition to the above named subjects which are required and for which substitutes cannot be accepted, applicants shall present evidence of preparation in **seven** year-credits, or their equivalent; of the credits thus offered, at least **two** year-credits shall be chosen from one of the **language groups.**

Latin (four years).
Grammar, one year.
Caesar, four books, one year.
Cicero, six orations, one year.
Vergil, six books, one year.

Greek (two years).
Grammar, one year.
Anabasis, one year.

German (two years).
Literature, one year.
Grammar, one year.

French (two years).
Grammar, one year.
Literature, one year.

Spanish (two years).
Grammar, one year.
Literature, one year.

History, Ancient, to Charlemagne, one year.
Modern, from Charlemagne, one year.
England, one-half year.
Senior American, one-half year.

Civics, one-half year.

Political Economy, one-half year.

Physics, one year.

Chemistry, one year.

Botany, one-half or one year.

Zoology, one-half or one year.

Astronomy, one-half year.

Geology, one-half year.

Physiography, one-half year.

Commercial Geography, one-half or one year.

Drawing, one year.

Shop Work, one year.

GENERAL REGULATIONS.

I. Students will be admitted to the freshman class on **passing the regular entrance examinations.**

II. No student will be admitted **if conditioned in more than three half-year subjects,** or their equivalent.

III. Graduates of any Minnesota State high school will be admitted **without examination, provided—**

(1) That the school maintain a **full four-year high school course.**

(2) That the applicant present to the registrar the principal's certificate showing the satisfactory completion **of all the studies required for admission** to the desired University course.

IV. Graduates of Minnesota State high schools who are deficient in **not more than three half-year subjects** or their equivalent, **may be excused** from entrance examinations **in such subjects as the enrollment committee may decide;** such candidates should present themselves to that committee **not later than Tuesday of examination week.**

V. Graduates of Minnesota State high schools whose principal's certificate shows them to be deficient in **more than three half-year subjects** or their equivalent, even though they have made such additional preparation as they deem necessary, must take, nevertheless, the regular entrance examination in all subjects, as provided in sections I and II unless excused by vote of the faculty; and persons wishing to present reasons for such excuse **should report to the enrollment committee not later than Tuesday of examination week.**

VI. Graduates of the **advanced courses of Minnesota normal schools** will be admitted upon the same terms as graduates of State high schools.

VII. Any Minnesota high school or academy **not under supervision of the State High School Board,** but requiring for graduation **a four year's course,** exclusive of the common school branches, conforming **essentially in distribution of time** to the entrance requirements of at least one of the University courses, will, upon application, be inspected by a committee, and, after favorable recommendation, **may be accredited by the faculty** in all respects as are the state high schools, **provided—**

(1) That the school be **open to inspection** at any time by the University;

(2) That it take such supplementary examinations as may be prescribed from time to time.

VIII. Graduates from schools in other states, whose diplomas admit to reputable colleges in the state in which the school is located, will be received subject to the regulations that apply to graduates of Minnesota State high schools. The University accredits schools in other states only under this general provision.

IX. Applicants from schools not coming within any of the above classes must take the regular entrance examinations or present State High School Board certificates. High School Board certificates will be accepted in lieu of an examination in the subjects which they represent.

Students bringing records from accredited schools are required to present them on the blank form provided for the purpose by the University. Blank forms may be obtained from the Registrar. No other form of certificate will be accepted. Students who do not bring their certificates on the proper form of blank will not be allowed to register until they have secured the certificate on the required form.

SYLLABUS.

The following statements indicate, in a general way, the ground expected to be covered in the study of the various subjects accepted for admission.

English (*four years*).

In order to secure a definite plan of study and unity of method on the part of preparatory schools, the entrance requirement in English is outlined below somewhat in detail. Where texts are mentioned they are merely suggestive and not arbitrary. Equivalents will be accepted in lieu of any of the texts mentioned. The entrance requirement in English covers four years of the high school course, and not less than four hours a week should be devoted to the subject. The headings under which instruction will naturally fall are:

(a) English classics.
(b) The principles of rhetoric.
(c) Practice in written expression.

(a) English classics should include a critical reading, in class, of English masterpieces. The following are suggested as well adapted for such study: Shakespere's "Macbeth," Milton's "Paradise Lost," books one and two; Burke's "Conciliation with America;" Carlyle's essay on "Burns." In the study of these works the student should come to know the leading facts connected with the author and his time; he should become familiar with the subject matter of the work; thoroughly at home with the story and have a clear idea of the form and structure of the work as a whole.

A less critical knowledge of other standard or classic works, which may perhaps be read by the student at home, with written reports and brief oral discussions in class. The following works are noted as indicative of the minimum amount of work expected: At least two of Shakespere's plays, beside the one read in class, one of Irving's works, one of Hawthorne's novels, one of Stevenson's novels, one of Webster's orations.

(b) The work in the principles of composition should include the principles and technical terms of ordinary texts upon the subject, whether acquired by the direct study of such texts or mainly by the study of selected English masterpieces. It should not be forgotten that this is not an end in itself, but simply a means of teaching the student the correct use of English.

(c) Not less than one hour each week throughout the four years of the high school course should be devoted to practice in written expression. The instructor may choose such topics as local conditions may require or make most profitable, but whatever line of work is pursued, the student should be taught to use language correctly and forcibly and learn to express himself clearly and logically in writing.

Elementary Algebra (one year).

Addition, subtraction, multiplication, division, factoring, highest common divisor, lowest common multiple, fractions, simple equations (with one, two, and several unknown quantities) followed by problems, theory of exponents, involution (including the binomial theorem for positive integral exponents), evolution, radicals, inequalities, ratio, proportion, progression, and quadratic equations with problems.

Higher Algebra, First Part (one-half year).

While this subject does not include any topics not named under elementary algebra, a much fuller treatment of those topics is expected in this work. Principles as well as processes should be learned, theorems and rules should be rigorously demonstrated, the exercises and problems should be more difficult, and students should be drilled in short methods and rapid work. Unless candidates have a good knowledge of the fundamental topics named below, they are not prepared to pursue successfully at the University the second part of higher algebra.

The topics are addition, subtraction, multiplication, division, factoring, highest common divisor, lowest common multiple, fractions, theory of exponents, involution, evolution, surds, imaginaries and simple equations with problems.

Plane Geometry (one year).

Any of the standard texts on this subject will furnish the necessary preparation. Isoperimetry, symmetry and maxima and minima of figures are not required. The exercises requiring solutions and demonstrations should not be omitted.

Solid Geometry (one-half year).

Any of the standard texts on this subject will furnish the necessary preparation. The exercises requiring solutions and demonstrations should not be omitted.

Latin Grammar (one year).

This will include the subjects of orthography, etymology and syntax. Proficiency is particularly desired in the following subjects: the analysis of the verb forms, the rules of syntax, and the principal parts of the irregular verbs.

Caesar (one year).

First four books, or selections from the seven books equivalent to four; or three books, with thirty pages of Cornelius Nepos, or two books with sixty pages of Cornelius Nepos. Special attention should be paid to the translation of passages of the text into correct and idiomatic English; grammatical questions connected with the text; more especially on the subjunctive mood, indirect discourse and the sequence of tenses. The pupil should be able to rewrite in oratio recta all the passages of oratio obliqua that occur in the text. The student is expected to be familiar with the life of Caesar and an account of his wars.

Cicero (one year).

Six orations: four against Catiline and any two of the following: "Poet Archias," "Ligarius," "Marcellus," "Manilian Law" (to count as two orations), the Fourteenth Phillipic, the student should be familiar with the life of Cicero and the history of his times.

Vergil (one year).

Six books of Aeneid, or five of Aeneid and one of the Metamorphoses of Ovid, or the Eclogues. The student should be familiar with the life of Vergil, and an account of his times and writings. A correct rythmical reading of the text is to be encouraged.

Greek Grammar (one year).

Xenophon's Anabasis (one year)—Four books.

German (two years).

First year—the pupil should acquire:

(1) A correct pronunciation, training of the ear, eye and organs of speech.
(2) A vocabulary of a thousand words of every day use; facility in combining these words into simple sentences. (As a means to this, 100 to 150 pages of easy narrative prose and poetry should be read, from which questions and answers may be formed. To test the student's memory and knowledge of the word-order he should relate or write out the story anew in his own words.)
(3) From two to three hundred German idioms.
(4) The essentials of German grammar, to be taught by means of oral and written exercises based upon the reading lessons.

Second year—

(1) Read 150 to 200 pages of prose and poetry.
(2) Practice in reading smoothly and with expression.
(3) Carefully translate selected passages of the text into idiomatic English (to translate easy sentences which the student already understands is a waste of time).
(4) Translate sentences from English into German, using words and idioms of the text read.
(5) Study topically German grammar; chief rules of orthography, etymology and syntax; illustrate these by words, phrases and sentences selected or composed by the student.

French (two years).

The principles of French grammar, including acquaintance with the verb, regular and irregular; an ability to translate easy English sentences into French and simple French prose into English.

Spanish (two years).

First year—Grammar and reader.
Second year—Grammar reviewed; reading of some modern writer; composition and conversation.

Ancient History (one year).

(a) This study should begin with from five to seven weeks upon the oriental peoples who have most influenced European development, noting the early civilizations in the valleys of the Nile and Euphrates, the spreading and meeting of these civilizations in the intermediate region, with notice of the more important states in that district, and the union of the East under Persia. This survey should aim to give an idea of the reach of recorded history, of the distinguishing features of the successive oriental nations, and of their more important influence upon later European development.
(b) In the Greek and Roman age emphasis should be put upon the evolution of institutions, and considerable attention should be paid to the later Hellenistic period, after the rise of Macedon, and to the Roman Empire, with its bearing upon subsequent history. Some of the work should be illustrated by the use of sources, and maps should be used constantly.
(c) The subject should be carried down to the establishment of Charlemagne's Empire. This will bring together all the chief lines of influence which were afterwards to make our modern world, will show the meaning of the preceding eras as can not be done if the study stops at an earlier date, and will leave the subject at a period of comparative order and simplicity.

Modern History (one year).

From Charlemagne to the present. The topics to which special attention are called are the period of disorder after Charlemagne and the consequent rise of feudalism, the Holy Roman Empire and the papacy, the medieval church, the crusades, the free cities, the rise of national monarchies, the intellectual renaissance and the Protestant reformation, the French Revolution and the subsequent democratic movements in politics and industry.

It is desirable to give at least half of the year to this last period from 1789.

Instead of these two subjects, Ancient and Modern History, the University will, until 1907, continue to accept the following:
History of Greece and Rome (one-half year).
Medieval History (one-half year).
Modern History (one-half year).

English History (one-half year).

The Saxon period should be passed over rapidly. In the remainder of the work, besides the narrative, constitutional points should receive attention, and easily accessible documents, like Magna Charter, should receive careful study.

Senior American History (one-half year).

No attempt should be made to cover the whole field in this time. Either the colonial history or the period from 1783 to 1832 offers quite enough material. In any case considerable use should be made of collections or documents and sources.

Civics (one-half year).

The subject should be approached from the historical side. The best arrangement is to combine the study with the senior American history and to give a year to the two.

Political Economy (one-half year).

Some good elementary text book should be mastered. It is desirable that students be encouraged to study local and general economic phenomena and conditions. The time should be wholly devoted to the elements of the science of political economy. The beginner should not be confused with problems of applied economics such as tariff, trusts, bimetallism, etc.

Physics (one year).

It is suggested that the year's work be confined to four of the seven subjects mentioned below.

1. Mechanics of solids; 2. liquids and gases; 3. sound; 4. heat; 5. light; 6 and 7, electricity and magnetism (to count as two subjects but not to be divided).

Chemistry (one or one-half year).

The full year's work should include a study of both the non-metals and metals with laboratory experiments illustrating the common chemical laws and the commoner chemical reactions.

The half year's work should cover the non-metals only, with laboratory experiments similar to the first half of the full year's work.

After the opening of the year 1906-07, the one-half year credit will not be accepted for admission.

Botany (one or one-half year).

Schools which give one-half year of botany should devote particular attention to plant relations, making the course largely ecologic in bearing. When a whole year is given to the subject, additional work upon plant structures should be offered, and together with fundamental conceptions of ecology a general idea of morphology and taxonomy should be the aim of the course.

Zoology (one or one-half year).

The course of zoology, whether a half year or a year course, should be a natural history rather than a modern morphological course. Collecting and classifying (as a means) should be encouraged as much as possible. Animals should be studied as living units, in their relation to one another and their environment. The general and special structural feature in relation to the habits, the food and manner of obtaining it, the enemies and means of protection against them, hibernation, migration, the differ-

ences in habits, form and structure between the old or mature animal and the young, the relation of parents to their offspring, etc.—in short, all about the life of the animal under consideration should be the prominent feature, and as much as possible of this should be made out by direct observation of the animal in its natural home and in confinement.

The course, on the whole, should aim to foster and develop a love for nature, train the power of observation toward accuracy and give a healthful stimulation to the imagination. The pupil should be guarded against the habit of confounding the facts of observation with his interpretation, his judgments.

The animals for direct observation should be selected from as many branches of the animal kingdom as possible, and the changes during the year in the character of the fauna of the locality in general as well as of some particular region should be noted. In some localities the work will of necessity be largely restricted to land and air animals, but no locality in Minnesota is so poor in animal life that very profitable work cannot be laid out along the line indicated above.

It will be noticed that such a course of necessity includes so-called laboratory work. The amount and extent of the laboratory work will depend upon conditions, but even under the best conditions it is hardly advisable to go into detailed dissections and embryology. Continued, repeated and close observation, aided now and then, by a simple hand lens or a compound microscope, will reveal an abundance of material and opportunity for disciplining the mind.

Astronomy (one-half year).

An elementary course in general astronomy as presented in any good modern text-book.

Geology (one-half year).

These sub-divisions should receive special attention; physiographic geology, which treats of the building of the land and the evolution of its existing contours; geo-dynamics, the study of the forces, atmosphere, water, terrestrial heat, plants and animals, modifying the earth; and a brief survey of historical geology.

Physiography (one-half year).

The following topics should be emphasized: Meteorology, to an orderly arrangement of the leading facts relating to the atmosphere, and its phenomena, including some acquaintance with the work of the U. S. Bureau; Land Sculpture, as it treats of the origin, development and decadence of land forms and the influence of these processes on the physical environment of man.

Commercial Geography (one-half or one year).

The work usually provided in larger schools will cover this requirement.

Drawing (one year).

The work usually provided in the manual training courses of high schools will satisfy this requirement.

Shop Work (one year).

The work, usually provided in the manual training courses of high schools will satisfy this requirement.

COURSE OF STUDY.

FRESHMAN YEAR.

First Semester.

The same for all courses: Mathematics, 5; English, 4; Qualitative analysis, 4; Shop work, 4½; Drawing, 4; Military drill, 2.

Second Semester.

For the civil engineering course: Mathematics, 5; English, 4; Qualitative analysis, 3; Drawing, 5; Surveying and platting, 4; Military drill, 2.

For the mechanical and electrical engineering courses: Mathematics, 5; English, 4; Qualitative analysis, 3; Drawing, 5; Shop work, 4½; Military drill, 2.

SOPHOMORE YEAR.

First Semester.

CIVIL ENGINEERING.	MECHANICAL ENGINEERING.	ELECTRICAL ENGINEERING.
Mathematics, 5.	Mathematics, 5.	Mathematics, 5.
Physics, 6.	Physics, 6.	Physics, 6.
Topography, 4½.	Shop work, 4½.	Shop work, 4½.
*Technological chemistry, 3.	Technological chemistry, 3.	Technological chemistry, 3.
Drawing, 3.	Drawing, 3.	Drawing, 3.
Military drill, 2.	Military drill, 2.	Military drill, 2.

Second Semester.

Mathematics, 5.	Mathematics, 5.	Mathematics, 5.
Physics, 6.	Physics, 6.	Physics, 6.
Drawing, 2.	Drawing, 2.	Drawing, 2.
Topography, 4½.	Mechanism, 3.	Mechanism, 3.
Highways, 2.	Shop work, 4½.	Shop work, 4½.
*Practical astronomy, 2.	Kinematic drawing, 2.	Kinematic drawing, 2.
Military drill, 2.	Military drill, 2.	Military drill, 2.

JUNIOR YEAR.

First Semester.

CIVIL ENGINEERING.

Mechanics, 5.
Physics, 3.
Mechanical laboratory, 2.
Curves and earthworks, 4½.
Field work, 3.
Stress in framed structures 3

MECHANICAL ENGINEERING.

Mechanics, 5.
Physics, 3.
Mechanical laboratory, 2.
Machine design, 4.
Shop work, 3½.
Dynamos and motors, 2.
Stress in framed structures, 2.

ELECTRICAL ENGINEERING.

Mechanics, 5.
Physics, 3.
Mechanical laboratory, 2.
Machine design, 4.
Shop work, 3½.
Dynamos and motors, 2.
Stress in framed structures, 2.

MUNICIPAL ENGINEERING.

Mechanics, 5.
Physics, 3.
Mechanical laboratory, 2.
Water analysis, 2½.
Curves and earthworks, 2.
Field work, 3.
Stress in framed structures 3

Second Semester.

CIVIL ENGINEERING.

Mechanics, 5.
Structural details, 3.
Stress in framed structures 3
Railroad work, 5.
Geology, 3.
Hydraulic laboratory, 2.

MECHANICAL ENGINEERING.

Mechanics, 5.
Machine design, 4.
Dynamos and motors, 4.
Electrical laboratory, 3.
Mechanical laboratory, 2.
Steam engines, 3.

ELECTRICAL ENGINEERING.

Mechanics, 5.
Machine design, 2.
Dynamos and motors, 4.
Electrical laboratory, 3.
Mechanical laboratory, 2.
Steam engines, 3.
Electrical design, 2.

MUNICIPAL ENGINEERING.

Mechanics, 5.
Biology, 3.
Stress in framed structures 3
Railroad work, 5.
Geology, 3.
Hydraulic laboratory, 2.

* Students pursuing the course in municipal engineering will choose qualitative analysis [2] in lieu of this subject.

SENIOR YEAR.

First Semester.

CIVIL ENGINEERING.

Masonry, 5.
Experimental laboratory, 2.
Electric power, 3.
Structural design, 5.
Political science, 2.
Water supply engineering, 4.
Thesis.

MECHANICAL ENGINEERING.

Thermodynamics, 3.
Prime movers, 2.
Mechanical engineering, 2½.
Machine design, 4.
(Steam engine.)
Mechanical laboratory, 4.
Political science, 2.
Elective, 2 to 4.
Thesis.

ELECTRICAL ENGINEERING.

Thermodynamics, 3.
Prime movers, 2.
Alternating currents, 3.
Electrical engineering, 2.
Mechanical laboratory 3.
Political science, 2.
Elective, 3.
Electrical laboratory, 2.
Thesis.

MUNICIPAL ENGINEERING.

Masonry, 5.
Experimental laboratory, 2.
Electric power, 3.
Structural design, 5.
Political science, 2.
Water supply engineering, 4.

Second Semester.

CIVIL ENGINEERING.

Structural design, 5.
Least squares, 2.
*Geodesy, 3.
Political science, 2.
Sanitary engineering, 3
Contracts
and
Specifications, 2.
Thesis, 4.

MECHANICAL ENGINEERING.

Thermodynamics, 3.
Mechanical laboratory, 4.
Machine design, 4.
or
Railway design, 4.
Political science, 2.
Elective, 2 to 4.
Contracts
and
Specifications, 2.
Thesis, 3.

ELECTRICAL ENGINEERING.

Alternating currents, 3.
Electrical laboratory, 3.
Eectrical design, 3.
Electrical engineering, 2.
Political science, 2.
Elective, 3.
Contracts
and
Specifications, 2.
Thesis, 3.

MUNICIPAL ENGINEERING.

Structural design, 5.
Public health, 1.
Bacteriology, 3.
Political science, 2.
Sanitary engineering, 5.
Contracts
and
Specifications, 2.
Thesis, 3.

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*Or an equivalent elective to be approved by the department.

Courses of Instruction

ENGLISH.

Course I. English. [4] Freshman I, II. MR. SANFORD

The work for this course is planned with special reference to the needs of engineering students. Two hours a week will be given to the study of English composition, and two hours to the study of a general survey of English literature.

Essays will be required every week. Special emphasis will be given to the subjects that an engineer must write upon when, in the line of his business, he makes specifications, estimates, description of processes or of principles, and their application to given results; or when he wishes to inform the public upon engineering work, its principles and details.

While in the study of literature one object will be the general broadening of the mind by an acquaintance with the masterpieces of English prose and poetry, especial attention will be given to the work of those writers who have handled scientific subjects with clearness and power.

MATHEMATICS.

In imparting a knowledge of the mathematical subjects, special emphasis is placed upon their practical application. This gives the student a firmer grasp of the more important parts of these subjects and some appreciation of their real value, before reaching those technical studies where mathematics furnishes the only sure basis for professional knowledge and a most powerful instrument for use in original research.

Course I. Higher algebra. Freshman I. 70 hours.

Advanced work on equations containing radicals, simple and quadratic equations, proportion, variation, progressions, summation of special series, binomial theorem, indeterminate coefficients, logarithmic series, Taylor's formula and the treatment of higher equations, including Cardan's rule for cubics.

Course II. Plane trigonometry. Freshman I, II. 45 hours.

Trigonometric functions of acute angles, of angles in general, applications of logarithms, solution of right triangles, general properties of triangles, practical applications, including the solution of cubic equations having real and unequal roots.

Course III. Spherical trigonometry. Freshman II. 25 hours.

Review of some truths of solid and spherical geometry. Napier's rules, solution of right spherical triangles, general properties of spherical triangles and the application of spherical trigonometry to the solution of practical problems.

Course IV. Analytical geometry. Freshman II, 36 hours; Sophomore I, 65 hours.

Co-ordinate systems, transformation of co-ordinates, algebraic equations of different degrees produced and discussed by the aid of these systems, transcendental equations and loci:—three dimensions; the point, plane, line, surfaces and solids.

Course V. Differential calculus. Sophomore I, II. 55 hours.

The differentiation of algebraic and transcendental functions, successive differentiation, series, derivatives, maxima, minima, tangents, subtangents, normals, subnormals, illusory forms, asymptotes, direction and rate of curvature, radius of curvature, evolutes, envelopes, singular points and curve tracing.

Course VI. Integral calculus. Sophomore II. 40 hours.

The integration of various algebraic and transcendental differentials, rectification of plane curves, quadrature of plane surfaces, areas of surfaces of revolution, cubature of volumes of revolution, and the production of the equations of loci by integrating certain conditional differentials.

Course VII. Some practical applications Sophomore II. 15 hours.

of the calculus to mechanics and physics, maxima and minima, center of gravity, center of hydrostatic pressure and moment of inertia.

The foregoing courses in mathematics are required, *in the order given,* of all undergraduates in each of the engineering courses.

Course VIII. Advanced calculus and differential equations. Junior or senior I, II. 24 hours.

Preparation courses V and VI.

Course IX. Method of least squares. Senior I. 36 hours.

PROFESSOR LEAVENWORTH.

A study of the combination and adjustment of observations and the discussion of their precision, especially as applied to engineering problems.

DRAWING.

Course I. (a) Freehand. Freshman I. [2] 68 hours.

Lettering, geometric forms and engineering details in outline, including working sketches, translations and the elements of perspective.

(b) Mechanical. Freshman I [2]. II [3] 170 hours.

Conventional methods, lettering, machine and structural details and standard sizes and shapes.

(c) Descriptive geometry. Freshman II. [2] 34 hours.

Problems relating to points, lines, planes, solids, interpenetrations, surfaces of revolution, tangents and developments, including the constructive geometry involved. Recitations and lectures.

Course II. Descriptive geometry. Sophomore I. [2] 68 hours.

Orthographic, isometric, horizontal, topographic, oblique and perspective projections, shades and shadows, line shading and brush tinting. Open to students who have completed course I.

(a) Civil.
(b) Mechanical and electrical.
(c) Mining.

Course III. Working drawings. Sophomore I [1]. II [2] 102 hours.

Engineering details, assembly drawing, tracing and blue printing. Study of shop methods and drafting room systems. Details are obtained from actual machines and structures as far as possible.

(a) Civil.
(b) Mechanical and electrical.
(c) Mining.

Course IV. Instrumental. I, II. [4] 238 hours.

Problems, projections, sections, developments and interpenetrations. With conventional renderings in line and wash.

FOR GRADUATES.

Course V. Advanced work in descriptive geometry and applications.
Course VI. Projective geometry.

MECHANICS.

(a) APPLIED MECHANICS.

Course I. Statics, dynamics and mechanics of materials. Junior I. 90 hours.

The laws of equilibrium, motion, work and energy as applied to rigid bodies, and a study of the strength and elastic properties of materials of construction required in the design of beams, posts, masonry arches and equilibrium polygon. Recitations and lectures. Open to students who have completed the work of the first two years in mathematics and physics.

Course II. Hydraulic and pumping machinery. Junior II. 90 hours.
Hydraulics, including the laws of the equilibrium, pressure and flow of fluids; the theory of the action of pumps. Recitations and lectures. Open to those who have completed course I.

(b) THEORETICAL MECHANICS AND MATHEMATICAL PHYSICS.

For Graduates and Undergraduates who have completed calculus and physics.

Course I. The potential function and spherical harmonics.
Course II. Analytical statics and electrostatics.
Course III. Dynamics of rigid bodies.
Course IV. Circular, hyperbolic and elliptic functions with their physical applications.

FOR GRADUATES.

Open only to those who have completed advanced work in mathematics.

Course V. Directional calculus, vector analysis and determinants.
Course VI. Analytical theory of the conduction of heat.
Course VII. Theories of elasticity and sound.
Course VIII. Wave theories of light, heat and electricity.
Course IX. Kinetic theory of gases.
Course X. Hydrodynamics and fluid motion.
Course XI. Theory of functions with applications.

PHYSICS.

FOR UNDERGRADUATES.

The mathematics of the freshman year are required as preparation for all courses in this department.

Course I.
(a) Mechanics, heat. [6] Sophomore I.
(b) Electricity and magnetism.
Recitations, experimental lectures and laboratory work. [6] Sophomore II.

Course II. Sound and light. [3] Junior I.
Recitations, experimental lectures and laboratory work.

Course III. Advanced laboratory work. Senior I, II.
Open to those who have completed course II.

FOR GRADUATES.

Course IV. Advanced work in some special field; experimental investigations being the principal feature of the work.

GEOLOGY.

Course I. Geology. Junior II, 51 hours. DR. SARDESON.
A condensed course in physical and historical geology, for civil engineers, geodynamics, structural geology, physiography, stratigraphic and historical geology are treated of successively. Excursions to typical localities will supplement work done in the class room. Lectures and references.

CONTRACTS AND SPECIFICATIONS.

Course I. Contracts. Senior II, 17 hours. DEAN PATTEE.
Lectures on the law of contracts; essential elements of a legal contract; contracts by agents; mutual assent; misrepresentation in the contract; invalidity of contract through fraud; alterations; consideration. Agreements—oral and written; enforcement of contract.

Course II. Specifications. Senior II. 17 hours. PROFESSOR FLATHER.
A study of engineering specifications. Classes of specifications; essential features; clauses; details. Examples. Lectures, recitations and practice in writing specifications.

ASTRONOMY.

Course I. Practical astronomy. Sophomore II. 34 hours.
PROFESSOR LEAVENWORTH.

Spherical co-ordinates; time; latitude; longitude, and other astronomical problems. Lectures.

POLITICAL SCIENCE.

Course I. Introduction to political science. Senior I. 34 hours. DR. SCHAPER.

A study of the state, its growth, forms and people. Lectures and reading.

Course II. Transportation. Senior II. 34 hours. PROFESSOR FOLWELL.

The evolution of transportation in the United States, and by railroads in particular. Economic aspects and public policy of railroads.

BIOLOGY AND BACTERIOLOGY.

Course I. Biology. Junior II. 54 hours.

Brief course in general biology. Microscopical examination of samples of water for small plants and animals of frequent occurrence in public water supplies. Sedgwick-Rafter method.

Course II. Bacteriology. Senior II. 54 hours.

Brief course in general bacteriology. Preparation of media and study of cultures, especially those of pathogenic bacteria found in water and sewage.

BOTANY AND PLANT PRODUCTS.

Course I. Timbers and timber diseases.
PROFESSOR MACMILLAN AND ASST. PROFESSOR FREEMAN.

Nature, origin, structure and mechanics of timber. The important timber trees of the northern United States. Classification and description of timber. Timber production and timber manufacture. Timber diseases, their nature and prevention. *Elective.* First semester. Two hours per week.

Course II. Plant products. PROFESSOR MACMILLAN.

This course will give a summary of the nature, production, manufacture, distribution and use of the principal plant products which are of economic and commercial importance. In general the classification of Wiesner will be followed and the material will be grouped under the captions of gums, resins, rubbers, opium, indigo, fats, oils, wax, camphor, starch, sugar, yeast, kelp, lichens, galls and ink, barks, fibres, woods, subterranean structures, leaves, flowers and inflorescences, seeds, fruits. *Elective.* Second semester. Two hours per week.

CHEMISTRY.

Course I. Qualitative analysis. Freshman I, II. 272 hours.
ASSISTANT PROFESSOR NICHOLSON.

The course includes the general reactions of the metals and their qualitative separation; reaction and identification of acids, followed by practical problems in qualitative analysis. Lectures and laboratory work.

Course II. Chemical technology. Sophomore I. 68 hours.
ASSISTANT PROFESSOR SIDENER.

Includes technical analysis of materials of engineering, with especial reference to iron and steel, lectures and laboratory work.

Course III. Qualitative analysis. Sophomore I. 72 hours.

Volumetric and gravimetric analysis.

Course IV. Water analysis. Junior I. 72 hours.

Sanitary chemical analysis of water. Samples collected by the students tested for nitrogen in its several conditions, chlorine, color, turbidity, hardness.

CIVIL ENGINEERING.

MUNICIPAL AND SANITARY ENGINEERING.

For the classes graduating in 1906 and thereafter, a course of elective studies is offered to students desiring to give special attention to the problems of city engineering, particularly those having a direct bearing upon questions of public health. The departments of chemistry, biology and bacteriology and also the State Board of Health have lent their aid to the efficiency of this course. A reduction in time given to structural work and geodesy makes it possible to devote more time to design of public works.

Course I. (a) Hydraulic engineering. Senior I. 40 hours.

Study of public water supplies, covering the means and methods of collection, purification and distribution of water to large and small communities. Details of construction. Turneaure & Russell's Water Supply: text. Lectures on water power development, irrigation, river and harbor improvements and drainage. Required preparation, mechanics II. (Recitations and lectures.)

Course I. (b) Hydraulic design. Senior. 56 hours.

A series of problems in calculation of quantities and design. Estimates of cost. Required preparation: mechanics II. (Drawing room.)

Course II. (a) Sanitary engineering. Senior II. 56 hours.

Sewerage systems: separate and combined, hydraulics of sewers,—relation to rainfall and run-off, determination of size and capacity. Surveys for drainage systems. design of system in detail, specifications, estimates of cost, inspection of work. Methods of disposal, irrigation, filtration, chemical precipitation, bacteriolytic methods. House drainage. Garbage disposal. Preparation required, mechanics II. Folwell's Sewerage: text. (Recitations and lectures.)

Course II. (b) Sanitary design. Senior II. 68 hours.

Problems illustrative of work in course II. A complete design for collection and purification of sewage. Ogden's Sewer Design, Rideal's Sewage, Moore's Sanitary Engineering, &c.: References. Preparation, mechanics II. (Drawing room.)

Course III. Public health. Senior II. 18 hours.

Lectures upon general problems concerning public hygiene, by the professor of bacteriology.

RAILWAY AND HIGHWAY ENGINEERING.

Course IV. Curves and earthworks. Junior I. 36 hours.

Problems attending final location surveys of railroads and track laying, theory of computation of volumes and preparation of preliminary estimates. Transition curve. Woodman: text book and notes.

Course V. Execution in field of practical problems. Junior I. 102 hours.

Illustrating the analytical work of course IV, including the computation of earthwork of railroad grades and pits, platting profiles and construction of maps.

Course VI. Railway location and estimates. Junior II. 102 hours

Reconnoitering and preliminary surveys are made, followed by field maps and final location; profiles and cross-sectioning of a new route for a railroad, involving four or five miles of relocation. Complete estimates covering the cost of earth and rock work, timber structures and right of way involved in the actual construction of the line are made, together with plans of important bridges and a right of way map of the adopted location.

Course VII. Railway economics. Junior I, II. 34 hours.

This course consists of a course of lectures once a week through the junior year. During the first semester the subject of structures of permanent way, related to course IV, is treated, also the economic consideration controlling in the final selection of a line, the fixing of the grade line and placing of contracts for construction. In the second semester the science of location is treated preparatory to course VI.

Course VIII. Highway construction and maintenance. Sophomore II. 36 hours.

The economic relation of highways in transportation, with a treatment of the practical questions relating to materials and methods necessary to maintain good streets and highways. Lectures, Baker as text, with collateral reading reports and essays. Tours of inspection of country roads and city pavements.

STRUCTURAL ENGINEERING.

Course IX. Stresses in framed structures.
Junior I. 85 hours. Junior II. 85 hours.

Theory of structures and determination of stresses by graphical and analytical methods, for static and for moving loads. Lecture, one hour per week; work in drawing room in computation and graphic statics, supplemented by daily informal lectures, four hours per week. Reference books. Sondericker's Graphic Statics, Johnson's Stresses in Framed Structures. Open to students pursuing the course in mechanics.

Course X. Structural details. Junior II. 102 hours.

Methods of proportioning individual members of framed structures and the design of joints and splices in steel and wooden structures. Practice in the use of handbooks of steel manufacturers. Design of a roof truss and railway plate girder bridge. Practice in making complete shop drawings. Six hours per week. Reference books: Handbooks of the Carnegie and Cambria Steel Companies. Johnson's Stresses in Framed Structures. Open to students who have completed first half of course IX.

Course XI. Structural designs. Senior I. 170 hours; II. 170 hours.

Theory and design of steel structures, including railway and highway bridges, standpipes and towers, and other problems of structural interest. Theory of higher structures. Reference: Johnson's Stresses, Merriman's Part III and IV Bridge Series. Ten hours per week. Open to students who have completed courses IX and X.

Course XII. Masonry construction. Senior I. 136 hours.

Properties of stones, bricks, cement and concrete, and their use in engineering structures. Foundations, retaining walls, piers and abutments, dams and chimneys. Theory of reinforced concrete. Theory and design of masonry arches. Design of stone and concrete structures. Lectures and textbook work, two hours per week; drawing room work, six hours per week. Reference books: Baker's Masonry, Church's Mechanics, and current periodical engineering literature. Open to students who have completed course IX.

Course XIII. (a) Experimental laboratory. Senior I. 68 hours.

Experimental tests of the properties of cements, concrete, reinforced concrete and strength of joints, columns and framed structures. Laboratory work, four hours per week.

(b) Cement laboratory. Junior I.

A short course in cement testing, supplemented by lectures upon the properties of cement and methods of testing. Given to all junior engineers in conjunction with the course upon strength of materials. Four hours per week for four weeks.

TOPOGRAPHICAL ENGINEERING.

Course XIV. Surveying. Freshman II. 68 hours.

Work consists of recitations, lectures and illustrative problems relating to chaining, field problems employing chain; methods of keeping field notes; determination of area—D. M. D. and rectangular coordinate method; compass and transit surveying; study of instruments and their adjustment; methods for overcoming obstacles, determination of heights and distances inaccessible; methods of supplying omissions of platting compass and transit surveys; discussions of the methods of laying out and dividing land, including the public land surveys of the United States. The care, proper use and adjustment of all instruments used are treated in field exercises. Chain, compass and transit surveys are made and circuits of level-lines run by each party. A meridian line is established by each party by observations on Polaris.

Course XV. Platting. Freshman II. 34 hours.

This time is given to construction of diagonal scales, protractors, circular and straight verniers. All surveys made in the field are platted and areas computed. Solution of problems and usual office reduction of all field notes.

Course XVI. Topography. Sophomore I. 96 hours.

The methods of conducting topographical surveys are taken up in the order of increasing accuracy. At first a text-book is used to acquaint the student with the instruments employed; method of use and theory of adjustment. Lectures are given on the details of field work; parties of topographers are formed and each makes a complete topographic survey of a certain tract, employing stadia transit and rectangular methods.

Course XVII. Mapping. Sophomore I. 40 hours.

Notes taken in course XVI are reduced, areas computed and topographical maps made of land surveyed.

Course XVIII. Higher surveying. Sophomore II. 102 hours.

Analytical study of the aneroid and mercurial barometers and barograph is made for determining their efficiency in hypsometric surveys; of the solar compass and solar transit and various solar attachments for establishing government standard lines and the plane-table and stadia as a rapid means of prosecuting topographical surveys. Text-books: Johnson's Theory and Practice of Surveying, and Baker's Engineering Instruments.

Course XIX. Field work and platting. Sophomore II. 68 hours.

Observations are made with barometers for difference of level; checked with spirit level. Meridians and parallels of latitude are run with solar compass and attachments, and an outline survey made, computed and platted. A plane-table survey, employing stadia and telemeter, is made by each party, and each student makes a map of the same. A general map is compiled from all the maps, a tracing made and blue prints taken by each student.

Course XX. Geodesy. Senior II. 51 hours.

Geodetic reconnaissance; base-line measurement, employing bars and steel tape; measurements of angles, horizontal and vertical; field methods for time, latitude, longitude and azimuth; theory of computing geographical position. Lectures and text. Making and reducing observations illustrating work of course.

MECHANICAL ENGINEERING.

SHOP WORK.

Course I. Carpentry and pattern making. Freshman I. 162 hours.

Wood working, use of tools; lathe and bench work. Patterns for moulding, core boxes. Lectures and practice.

Course II. Foundry practice and pattern making. Freshman II. 162 hours.

Patterns and flasks. Moulding, casting, mixing metals, brass work and core making. Shop practice, recitations and lectures.

Course III. Blacksmithing. Sophomore I or II. 90 hours.

Use of tools, forging, welding, tool dressing, tempering. Lectures and practice.

Course IV. Machine work. Sophomore I and II. 270 hours.

Chipping, filing, machine work, gear cutting, finishing; machine construction. Lectures and practice.

Course V. Tool construction. Junior I. 108 hours.

Tools, taps, reamers, cutters and other special work. Lectures and practice. Preparation, course IV.

Course VI. Carpentry, joinery and wood carving. I or II. 144 hours. (Elective.)

A course in wood working designed with special reference to the needs of teachers of manual training.

Course VII. Machine construction. Senior I or II. 144 hours. (Elective.)

Construction of patterns and machine work for special apparatus, or machinery, designed by the student.

Course VIII. Shop economics. Senior II. 36 hours. (Elective.)
Shop and factory organization and management; cost systems.

MACHINE DESIGN.

Course IX. Principles of mechanism. Sophomore II. 54 hours.
The transmission of motion without consideration of the strength of parts. Gear wheels, cams, belts, screws, epicyclic trains, parallel motions, quick-return movements. Lectures and recitations. Preparation: course V in mathematics.

Course X. Kinematics. Sophomore II. 72 hours.
Graphical diagrams of the paths, speeds and accelerations of important mechanisms; centroids; analysis of mechanisms; construction of cams; kinematic pairs. Preparation: course IX.

Course XI. Machine design. Junior I and II. 216 hours.
Calculation and design of such machine parts as fastenings, bearings, rotating pieces, belt and tooth gearing. Recitations, lectures and drawing-room practice. Preparation: course VIII, mathematics; and course I, physics.

Course XII. Machine design. Junior II. 72 hours. (Second half semester.)
Application of graphical methods to the design of valve gears and link motions; Zeuner diagrams, indicator cards. Lectures and drawing-room practice. Preparation: course I, applied mechanics.

Course XIII. Machine design. Senior I. 144 hours.
Calculations and working drawings for a high speed automatic steam engine. Theoretical diagrams and determination of details. Preparation: courses XII and XVII.

Course XIV. Machine design. Senior II. 144 hours.
Original designing, including machinery for changing size and form. Boiler design, cranes, pumping and transmission machinery and engineering appliances. Lectures, problems and drawing-room practice. Preparation: course XI.

Course XV. Tool design. Senior I or II. 72 or 144 hours.
Design of special tools for manufacturing interchangeable parts; jigs and milling fixtures. Preparation: courses V and XI.

Course XVI. Engineering design. Senior II. 72 or 144 hours.
Problems, designs and estimates for power plants, central stations and factory equipment. Selection of motive powers, pumps, shafting, piping and accessory plant. Preparation: courses XIV and XXI.

STEAM ENGINEERING AND PRIME MOVERS.

Course XVII. Steam engine. Junior II. 36 hours.
Mechanics of the steam engine. Work in the cylinder; effect of reciprocating parts; steam distribution;. Mechanism of the steam engine. A study of the details of modern steam engines. Valves and valve gears. A study of the slide valve, link motions and other reversing gear; automatic cut-off gears and the Zeuner diagram. The steam engine indicator. Principles and operation of the instrument, indicator rigging; indicator cards; compounding. Preparation: course I in applied mechanics.

Course XVIII. Thermodynamics. Senior I. 54 hours.
The mechanical theory of heat as applied to the steam engine and other motors. Preparation: courses I and II in applied mechanics.

Course XIX. Thermodynamics. Senior II. 54 hours.
First half semester: Gas and oil engines, including devices for starting, igniting, and governing; gas producers; the adaptation of oils for generating power.

Second half semester: Refrigerating machinery and ice manufacture; air compressors and motors, and the transmission of power by compressed air. Preparation: course XVIII.

Course XX. Prime movers. Senior II. 36 hours.
Theory of turbines, hydraulic motors and wind mills. Preparation: course II in applied mechanics.

Course XXI. Mechanical engineering. Senior I. 45 hours.

First half semester: Measurement of power. A study of the methods employed in measuring power. Dynamometers, Prony brakes; measurement of water power; water meters, weir measurements, flow of water in pipes; measurement of electric power, efficiency of motors; power required to drive machine tools and shafting. Recitations. Preparation: course II in applied mechanics.

Second half semester: Steam boilers. Application of theory and practice in the design and construction of steam boilers, chimneys, boiler settings and accessories, smoke prevention, incrustation; methods of operating boilers with safety and economy. Preparation: course I in applied mechanics.

Course XXII. Mechanical engineering. Senior I. 36 hours. (Elective.)

Heating and ventilation. Principles of heating and ventilation. Construction and operation of heating apparatus. Steam, hot water, exhaust, vacuum and fan systems. Lectures, recitations and problems.

Journal Club—Open to the seniors and juniors. Once a week.

ENGINEERING LABORATORY.

Course XXIII. Strength of materials. Junior I. 72 hours.

Laboratory work investigating the strength and physical qualities of iron, steel, brass, copper, belting, chains, beams, brick, stone and cement. Preparation: course I, applied mechanics.

Course XXIV. Mechanical laboratory. Junior II. 72 hours.

Continuation of course XXIII; also exercises in valve setting, indicator practice, calibration of steam gauges, efficiency of screws and hoists. Preparation: course XVII.

Course XXV. Hydraulic laboratory. Junior II. 72 hours.

Hydraulic measurements, calibration of weirs, nozzles, orifices and meters, tests of water meters, rams, pulsometers, pumps and other hydraulic apparatus. Preparation: course XXIII.

Course XXVI. Mechanical laboratory. Senior I. 144 hours.

Hydraulic measurements. Calibration of weirs, nozzles, orifices and meters. Tests of water motors, rams, pulsometers, steam pumps and other hydraulic apparatus. Calibration of dynamometers and other apparatus. Testing lubricating value of oils; calorimetry, tests of injectors, steam-engines and boilers. Preparation: course XXIV.

Course XXVII. Mechanical laboratory. Senior II. 144 hours.

Tests of gas and hot air engines, locomotive testing, and special work. Preparation: course XXV.

Course XXVIII. Mechanical laboratory. Senior II. 72 or 144 hours.

Continuation of course XXVII; flue gas analysis and coal calorimetry; special research work, commercial tests.

Course XXIX. Mechanical laboratory. Senior II. 72 hours.

Special modification of courses XXVI and XXVII, covering work in hydraulic measurements, steam engine and boiler testing for students in mining and metallurgy.

RAILWAY MECHANICAL ENGINEERING.

The following courses are available to seniors desiring to prepare themselves for special work in railway engineering.

Course XXX. Railway technology. Senior I. 72 hours.

The object of this course is to familiarize the student with the principal details of construction of locomotives, and consists of a systematic course of shop visits carried on in the various railroad shops in the vicinity.

Course XXXI. Railway design. Senior II. 144 hours.

(a) Of link and valve motions. Continuation of course XII with special applications of the Stephenson link.
(b) Of locomotive and car details.
(c) Of the locomotive boiler.
(d) Of assembled parts. Preparation: course XXIX.

Course XXXII. Locomotive construction. Senior II. 36 hours.

Lectures, reading and recitations on design and construction of locomotives, supplementing course XXX. This treats—

(a) Of parts not involving the boiler and use of steam; but including the carriage, as frames, springs and equalizing arrangements, running gear, brakes, trucks, lubrication.
(b) Of locomotive boilers and connected parts. Types, proportions, grates, flues, smoke-box arrangements and stacks. Riveted joints, bracing and staying. Lagging, smoke prevention.
(c) Of the locomotive engine. Details, heat insulation, cylinder proportions for various types, weight on drivers, special service; crank effort diagrams with inertia of reciprocating parts, cylinder and receiver ratios for compound engines, starting valves for compounds.

Course XXXIII. Locomotive road testing. Senior II.

FOR GRADUATES.

Courses are offered in:

Engineering design.
Experimental investigation.
Railway engineering.

ELECTRICAL ENGINEERING.

Course I. Industrial electricity. Junior I. 34 hours.

Outline of industrial uses of electricity; application of Ohm's law; methods and calculation of wiring; electrical measurements. Text book: Shepardson, Electrical Catechism. Preparation required: physics, course I.

Course II. Dynamos and motors. Junior II. 68 hours.

Theory of electro-magnet and direct current dynamo and motor; methods of regulation, construction and operation of dynamos and motors; methods of testing. Text-book: Thompson, Dynamo Electric Machinery. Preparation required: electrical engineering, course I; physics, courses I and II (a); differential and integral calculus.

Course III. Electric laboratory. Junior II. 102 hours.

Tracing circuits and locating faults; measurements of conductivity and insulation; construction and use of instruments; calibration of instruments; tests of batteries; operation of characteristic curves of dynamos and motors. Preparation required: physics, courses I and II, electrical engineering, courses I and II.

Course IV. Electrical design. Junior II. 68 hours.

Problems in designing circuits, electro-magnets and dynamos; complete working drawings and specifications to accompany each design. Text-book: Wiener, Dynamo Electric Machines. Preparation required: physics, courses I and II; electrical engineering, courses I and II; machine design, course XI.

Course V. Electric power. Senior I. Civil and Mining Engineers. 82 hours.

Elements of theory and practice of electrical measurements, wiring, dynamos, motors and electric lighting. Thirty-six lectures and recitations and forty-eight hours laboratory. Text-book: Shepardson, Electrical Catechism. Preparation required: physics, course I.

Course VI. Alternating currents. Senior I, II. 102 hours.

Phenomena, measurement and use of alternating currents; theory of line, transformer, generator and motor; types of apparatus. Text-book: Steinmetz, Alternating Current Phenomena. Preparation required: electrical engineering, courses I and II.

Course VII. Electrical engineering practice. Electric lighting. Senior I. 17 hours.

Comparison of different sources of light; photometry, physics of the arc; history, design and regulation of arc lamps; adaptation to constant currents, constant potential and A. C. circuits; carbons; history, manufacture and economy of incandescent lamps; distribution of light. Text-book: Bell, Art of Illumination. Preparation required: electrical engineering, course II.

Course VIII. Electrical engineering practice. Batteries. Senior I. 17 hours.

General theory of primary and secondary cells; types and methods of construction; commercial applications; operation of battery plants; construction and test of cells by students; test of a commercial plant. Text-book: Lyndon, Storage Battery Engineering. Preparation required: electrical engineering, course II.

Course IX. Electrical engineering practice. Electric railway.
Senior I. 17 hours.

History and development; different systems of distribution, location and calculation of feeders; line and track construction; choice of motors, trucks, generators and engines; operation and repairs. Text-book: Gotshall, Electric Railway Economics. Preparation required: electrical engineering, course II.

Course X. Electrical engineering practice. Electrical transmission.
Senior II. 17 hours.

Utilization of natural forces; various methods of transmission; theory of electric motor; power distribution with constant current, constant potential and alternating systems; design of line; study of particular plants. Twenty-four lectures. Preparation required: electrical engineering. courses I, II and VI.

Course XI. Electrical engineering practice. Central stations.
Senior II. 34 hours.

Preliminary surveys; choice of electrical systems; load diagrams; best units of power; comparison of steam, gas and water power; location, design and erection of station building; boilers, engines, dynamos, storage batteries, switch board and lines; operation and regulation; maintenance of plant; emergencies; examination of stations in Minneapolis and St. Paul. Twenty-four lectures. Preparation required: electrical engineering, courses II and VI; mechanical engineering, courses in thermodynamics and prime movers.

Course XII. Electrical engineering practice. Telegraph and telephone.
Senior II. 34 hours.

Various systems and instruments used in local and long distance telegraphy and telephony, design and construction of switchboards and lines; protection from inductive and other disturbances; police, fire alarm and district messenger systems. Twenty-four lectures with problems. Preparation required; electrical engineering, courses I and VI.

Course XIII. Electrical laboratory. Senior I. 68 or 136 hours.

Photometric and electrical tests of incandescent and arc lamps and regulating devices. Experimental study of alternating currents; regulation and efficiency tests of alternators, transformers, rotaries and motors.

Course XIV. Electrical design. Senior I. 68 hours.

Design of a dynamo or other problem as assigned. Preparation required: electrical engineering, courses II *and* IV.

Course XV. Electrical design. Senior II. 102 hours.

Designs, specifications and estimates for an electric light or power plant, or other approved problem. Preparation required: electrical engineering, courses IV and VI.

Course XVI. Electrical laboratory. Senior II. 102 hours.

Efficiency tests and special problems.

Course XVII. Plant operation. Senior I, II.

Practice in operation and care of boiler, engines, motors, dynamos and circuits of the University lighting plant. One evening a week through one or two half semesters.

Course XVIII. Electrochemistry. Senior II. 34 or 68 hours.

Theoretical and experimental study of electrolysis, electrodeposition and electric furnaces.

Course XIX. Journal reading. Senior I. 34 hours; II. 34 hours.

Discussion of current electrical periodicals.

Course XX. Dental electricity. Senior [Dentists.] 25 hours.

Electrical and magnetic units; electrical instruments and measurements; electro-dental apparatus. Recitations and experimental lectures. Text-books: Shepardson, Electrical Catechism, and Custer, Dental Electricity. For seniors in dentistry.

NOTE.—Senior electrical engineers are required to take 68 hours of electrical engineering practice selected from courses VII *to* XII. Electives may be chosen from any courses given in the academic or engineering colleges for which the student is prepared.

EQUIPMENT.

As an organization of the University of Minnesota, the college of engineering and of the mechanic arts has the general advantage of the University. Students find available all the resources of the institution so far as their technical lines will permit their use. For the information concerning methods of work and equipment, the following condensed statements are offered:

CIVIL ENGINEERING.

Geodesy. For this work the department has a secondary base-line apparatus, a three hundred foot standard steel tape, astronomical transits and repeating theodolites, heliotropes, a telemeter, deflection magnetometer, precise levels, two marine chronometers, one on sidereal and the other on mean solar time.

Highway engineering. The department has suitable apparatus for conducting the usual tests applied to road materials.

Railroad work. The usual equipment of transits, levels, planimeters, gradientors, level-rods, range-poles, chains and tapes, is provided.

Surveying. The department has for this work the necessary outfit, consisting of compasses—plane, railroad and pocket, transits, tapes, hand levels, aneroid and mercurial barometers, solar compasses and solar attachments, pantometers and anemometers.

Structural engineering. The department has a collection of drawings of prominent structures throughout the country; photographs of bridges, buildings and roofs, in this country and abroad.

The cement and concrete laboratory is being rapidly developed and offers excellent facilities for experimental work with cement and its products. In connection with the experimental laboratory work of this department there is a large Olsen testing machine of two hundred thousand pounds capacity, with complete atttachments, including automatic and autographic recording apparatus, extension head for full sized columns ten feet long, and transverse beam for bending tests upon twenty foot beams.

Municipal and Sanitary Engineering. A special course has been planned and is now offered to students in civil engineering. Laboratory work is given a prominent place in the cur-

riculum. A collection of drawings and blue-prints of typical structures is being collected.

Topography. For this work the department has plane-tables, telemeter rods, stradia-transits, reduction charts and slide rules, clinometers, pedometers, current-meters, compasses, a relief map, a complete topographic map of the District of Columbia, besides a large collection of topographic sheets presented by the United States coast and geodetic, and geological surveys.

Library. The civil engineering library is located on the main floor of engineering building where are to be found all the more important books relating to this line of work. There are complete sets of the leading technical journals and proceedings, and reports of a large number of state and university engineering societies.

Reading Room. Here are to be found all the leading American periodicals, and some foreign, relating to civil engineering. The files of the most important are bound and are easy of access to the student.

Methods of instruction. It is the aim of the department to secure for its students special training in the preparatory studies which form the basis of all engineering work—such as mathematics, physics, mechanics and drawing—these being the tools for the special engineering which follows.

A thorough course is then given in the theory and practice of the more important professional lines, such as railroad and structural engineering and topography. Considerable time is devoted to hydraulics, municipal engineering, higher surveying and geodesy.

While theory is at all times made prominent it is always accompanied by practice according to the methods followed in actual professional work.

Inspection tours. The professional work of the department is illustrated in a practical manner by frequent visits to the engineering works and plants in the vicinity of Minneapolis and St. Paul.

MECHANICAL ENGINEERING.

The plan of instruction in this course is intended to give the student a thorough training in mathematics and the physical sciences; and in the fundamental principles of engineering.

The work is planned to make him familiar with the various applications of these principles, and with the practical details of machine construction and design.

A new building especially designed to meet the requirements of instruction in the various lines of shop work, has recently been erected and the increased facilities thus afforded for the prosecution of this work are unexcelled.

This building consists of a two-story portion, containing the machine shop on the first floor and the wood shop on the second; beyond the machine shop and at a different level is the forge shop and foundry, both one story in height.

Slow burning mill construction is used throughout. This consists of brick walls and heavy timbers which, in case of fire, burn slowly and are safer than the ordinary iron and timber combination for this class of buildings.

A two-story extension has recently been added in which are located the mechanical engineering lecture and recitation rooms, drawing rooms, library and offices.

In the machine room a three-ton crane will cover a clear span of 12 feet, the entire length of the shop, thus giving ample space for erecting. This crane will also serve some of the larger machine tools.

The foundry has been the subject of especial study and possesses many features of interest and value. In accordance with the best modern practice for light work the floor is of concrete, and the gangways, leading from the cupola and extending lengthwise of the room, are of heavy iron plates set in cement.

A light traveling crane is also provided for the foundry. This has a span of 18 feet, and runs the entire length of the room.

The lighting, heating and ventilation of the building has received careful consideration. In the machine and pattern shops 60 per cent of the wall space above the benches is in glass. In the foundry and forge shop less light is allowed, since an abundant supply of overhead light is obtained from windows placed in the lantern or ventilator which extends over the roof. Pipe coils are employed in heating the building, and these are placed partly on the side walls under the windows and partly overhead. Electric power is used for driving the machinery. The group system has been selected as best adapted to the conditions, and a number of small motors are placed in the several

departments; 220-volt continuous current motors are employed in connection with a three-wire system of distribution, which is also used in the lighting circuit.

The machine shop contains representatives of the ordinary machine tools, gauges, and small tools usually found in a well-equipped modern plant.

The shop for pattern making and general wood work contains benches with vises and tools, lathes and lathe tools, an improved universal sawing machine, band saw, planer, and other power tools, and all hand tools used in carpentry and pattern making.

The forge shop is equipped with stationary and portable forges, a blower and exhaust fan, a one hundred pound drop hammer, and the necessary small tools used in blacksmithing.

The foundry contains a thirty-inch Whiting cupola, and two brass furnaces, which embody some novel features. There are two core ovens; one for ordinary work 3½x3½x5 feet, and one 3½x7x6 feet for special cores which may be required. The feature of these core ovens is that the gases and products of combustion are caused to traverse suitable conduits under a plate floor and do not come into direct contact with the cores, The usual moulding tools, ladles, crucibles, and all of the tools and material needed in moulding and casting iron, brass or white metal, are provided.

The shop work is intended, not so much to give the student skill in the manual operations of the respective crafts, as a knowledge of the methods and processes of practical construction.

The mechanical laboratory, in which the experimental research of the department is conducted, has been considerably enlarged and its equipment greatly increased. Two testing machines of 50,000 pounds and 100,000 pounds capacity, and three transverse testing machines are provided for determining the strength, ductility, resilience and other characteristics of the various materials used in engineering work under tensile, compressive, transverse and torsional stress. Several forms of absorption and transmission dynamometers are available for determining the power generated by engines or other motors, or absorbed by shafting or machinery; a Carpenter coal calorimeter for determining the heat value of coal, and apparatus for the analysis of flue gases.

The laboratory is also provided with two machines for determining the lubricating qualities of oils and the relative values of metals used for journals and bearings; a mercury column and a Crosby direct pressure-gauge tester, for use in calibrating gauges and other pressure indicators. Besides the boilers in the university heating plant, there are in the laboratory, a 35 horse-power boiler and a high pressure boiler capable of carrying a working pressure of 300 pounds, with the necessary gauges, calorimeters, tanks and pyrometer, for making complete duty trials; several automatic steam engines equipped with condensers, indicators, brakes, scales and thermometers, which are employed to determine the efficiency in the use of steam under various conditions assumed or found in actual practice, and for valve setting and indicator work.

The operation and economy of other heat engines are illustrated by an Otto gas engine of five horse-power, a White gasoline engine of eight horse-power, a Rider two-cylinder and an Ericsson single cylinder hot air engine, a pulsimeter, and several steam pumps. The equipment also contains a Pelton and a Tuerk water motor, a water ram, injectors, weirs, nozzles, meters and other pieces of apparatus and instruments which an engineer is called upon to use in the course of his professional work.

The new engineering power plant is admirably equipped with other steam apparatus which constitutes a valuable part of the laboratory equipment.

The boiler plant contains a 130-h.p. Cahall (B. & W. type) water tube boiler designed to carry a working pressure of 250 pounds; a 60x16 foot multitubular boiler which carries 175 pounds pressure; a Sorge-Cochrane purifier of 300-h.p. capacity; and a 72-inch Sturtevant fan and direct-connected engine, to be used for experiments with mechanical draft.

In the engine room there is an Allfree automatic expansion 75-h.p. engine, connected by belting to a jack shaft equipped with roller bearings. A 150-h.p. cross-compound Corliss engine especially designed for the mechanical enigneering department is now being constructed and will be installed at an early date.

This engine will be provided with a condenser and is arranged so that it may be run simple or compound, condensing or non-condensing, as desired. It will constitute a valuable part of the equipment of the experimental laboratory.

A constantly increasing quantity of commercial testing is being done in connection with the regular work of the course, which brings the student into actual contact with the engineering world and affords him valuable experience and data for his future work.

The library of the department contains a collection of historic and recent works, the best standard books being purchased as soon as issued. There are a number of complete files of the transactions of engineering societies and of the leading technical publications. The reading room is amply supplied with both the general mechanical and railway press.

Railway mechanical engineering. Courses have been arranged for students wishing to specialize in this subject. The various courses may be elected separately, subject to the requirements for previous preparation, to fill out the electives, or options in the regular senior year of any department.

Students planning to elect these courses are encouraged to work, under special arrangements, in railway shops during the summer vacations. This has proved its value as preparatory to the special work of the senior year. In every possible way the methods of the department are intended to place the students in touch with the best railway work; keeping always in sight the limitations which railway experience has found financially and practically to exist.

The location of the University is particularly favorable, being between the cities of St. Paul and Minneapolils in proximity to the shops, yards and headquarters of the extensive railway systems of the Northwest, which offer exceptional facilities for the prosecution of this work. The Northwest Railway Club, meeting monthly for papers and discussions, is open for the attendance of students, while several are enrolled as members.

Visits of inspection. During the year numerous visits are made to the manufacturing plants of Saint Paul and Minneapolis, which have proven to be of great value in supplementing the class room work.

ELECTRICAL ENGINEERING.

The new electrical building provides permanent quarters for the electrical departments. One portion of the building, 92 feet long and 50 feet wide, contains the University electric light and power plant. The main portion of the building,

which is 80 feet long and 60 feet wide with two stories and basement, is devoted to the work of the electrical engineering department of instruction. In the basement are the electro-chemical laboratory, battery room, toilet and stock rooms. On the first floor are the dynamo laboratory, high tension laboratory, standardizing laboratory, office, instrument room and shop. On the second floor are laboratories for photometry, photography, meter and lamp testing and rooms for recitations, draughting, library and office.

The laboratory equipment includes about forty dynamo electric machines of various types and sizes for direct and alternating currents, such as constant current and constant potential direct current generators and motors, single phase and polyphase alternators, commutating, induction and synchronous motors and rotary converters, each furnished with suitable regulating devices. A number of these machines have been equipped with special devices for experimental purposes. Lamps, rheostats, batteries, fans and brakes afford convenient and ample means for taking up the energy of dynamos and motors. To facilitate testing, there are a number of pairs of similar machines. A three-ton traveling crane facilitates handling the machines. Power is obtainable from a main shaft driven by the engines of the lighting plant, or by motors connected with the University power circuits, with a storage battery or with the circuits of The Minneapolis General Electric Company, which supplies direct current at 500 volts and alternating current at 2,250 volts. An excellent assortment of instruments of well-known American and foreign makers is available for laboratory use. A well equipped standardizing laboratory furnished with certified standards of current, electromotive force and resistance, allows the frequent checking of instruments, so that students may work to any desired degree of refinement. The meter and lamp testing laboratories are furnished with a wide variety of arc and incandescent lamps and meters with all necessary standards and other accessories. The electro-chemical laboratory provides facilities for the construction and testing of various cells, for electroplating and other electrolytic processes and for the formation and study of electric furnace products. Alternators, rotary converters, transformers, lamps, motors, condensers, special apparatus and suitable instruments afford facilities for the experimental study of alternating currents.

The department library contains an excellent collection of electrical and allied works, including a full set of United States Patent Office Gazettes. New books and trade publications are being added continually. Files of twenty-two journals are nearly complete and others are being collected and bound. These, with the files in the general and other departmental libraries of the University, offer excellent facilities for research work.

The reading room receives regularly the leading American and foreign periodicals devoted to electrical engineering and allied interests. A journal club meets weekly for the discussion of current literature in mechanical and electrical engineering, keeping the students in touch with current progress and best modern practice and teaching them the value of the technical press.

There is a growing collection of samples furnished by various manufacturers and dealers, a great help in exhibiting best modern practice and in teaching young engineers to appreciate the merits of different products. A collection of samples from repair shops and elsewhere is of special value in illustrating the treatment received by apparatus in commercial use and the necessity of careful design and construction. Free access is given to the private libraries and collections of the professors.

Instruction. The course aims to give the students a knowledge of phenomena and principles and the various applications of electricity, the methods and instruments used in measuring and transforming it, and practice in the design and operation of electrical apparatus. Practice and theory are taken together as far as possible. During the junior and senior years students have daily work with electrical instruments and apparatus and with commercial problems. Occasional inspection tours among the extensive and varied electrical interests in Minneapolis and St. Paul furnish excellent illustration. The University electric light and power plant, which is in the same building, affords opportunity to observe commercial conditions at close range.

All engineering students are strongly advised to spend their vacations in factories, repair shops, electric light and railway stations, etc., in order to obtain commercial experience, and that they may better appreciate the relations of their technical training and actual work.

It is the aim to train the students to be independent and efficient workers, and to adopt the methods of professional engineers. Students are required to verify the formulas used in various calculations, and are encouraged to derive their own formulas for simplifying work in special cases. At the same time they are expected to use logarithms, slide rule, tables, curves, charts and all legitimate means for obtaining accurate results with least amount of drudgery.

The regular instructing force is supplemented by competent non-resident lecturers. The regular monthly meetings of the Minnesota members of the American Institute of Electrical Engineers are held in the Electrical Building at the University, and are open to the advanced students in electrical engineering.

Laboratory work. In the more advanced work students are encouraged to determine for themselves as independent workers the best methods and conditions for accurate results. While the laboratory work is classified, the students are treated individually and are advanced as rapidly as their attainments warrant.

In fitting up the laboratory, care is taken to secure representative types of apparatus of commercial style and size, in order to acquaint the students with actual practice. In putting up new lines and in setting up apparatus, the students are required to work in accordance with standard practice. Each student is given a certain amount of practice in the construction of electrical apparatus.

Design. The electrical engineers have drawing and design in common with the mechanical engineers in the first three years. A large number of numerical problems are given during the course. During the junior and senior years, electromagnets and mechanisms, dynamos and motors, lines, switches, switchboards and plants are designed. Complete working drawings and specifications for some special problems are elaborated. A file of nearly 600 blueprints and drawings in the department library in adition to those in other departments is available to the students.

LIBRARIES AND READING ROOMS.

The reference libraries of the several departments are well supplied with technical literature. In the engineering building is a library consisting chiefly of books devoted to civil and

mechanical engineering, comprising over one thousand volumes; the library of the department of engineering and mechanics numbers eighteen hundred volumes of choice mathematical and scientific works; the departments of electrical engineering and physics together have an excellent collection of standard works which numbers over fourteen hundred volumes; the chemistry library contains over five hundred technical works; a choice collection of between one and two hundred volumes relating to drawing, art and design. The above number, upwards of four thousand volumes, comprising many works which are the private property of professors, yet accessible to the students.

In addition to the above are the libraries of the University, the City of Minneapolis, the City of St. Paul and others, containing many works of value to the engineering. Standard works bearing on special subjects are secured as they appear and the more important scientific and technical periodicals are secured and placed in the reading rooms maintained in connection with the several departments of the college.

Journal clubs are organized, in most of the departments, for the discussion of current technical literature, relating to the best modern practice. Thus students are kept in touch with the developments along engineering lines and are taught how to use the technical press.

In addition to the foregoing the college has many periodicals donated by the societies publishing them, and others loaned by members of the faculty, who at all times place their periodical list and entire professional libraries at the disposition of the students.

THE SOCIETY OF ENGINEERS.

This society is an organization holding regular meetings for the purpose of discussing topics of current interest, hearing reports and lectures from members of the faculty and others. During the past year the special lecturers of the college have delivered their lectures under the auspices of this society. A Yearbook of the society is published, which presents the progress of the original work done both by instructors and students.

THE BRIGGS PRIZE IN FOUNDRY PRACTICE.

For the encouragement of studies in foundry practice Mr. O. P. Briggs, commissioner of the National Foundrymen's Association, Detroit, Mich., offers $75 annually in two prizes,

which are to be accompanied by gold medals. The competition is open to sophomores in the College of Engineering, and the prizes will be awarded for the best essays relative to the above subject. The ordinary rules governing competitions of this character will obtain.

Essays should contain about 3,000 words, and must be submitted to the professor of rhetoric on or before May 1st. No prize will be awarded if less than five essays are received.

THESES.

Theses. Every member of the senior class in this college is required to prepare a thesis on some subject particularly relating to his course. The thesis must embody the results of original research made by the student himself and be creditable from a literary as well as from a technical point of view.

Theses are to be writtten in a clear hand, or typewritten and the paper used to be of the standard size and quality adopted by the University; all charts, maps, drawings or other illustrative matter are to be presented on tracing cloth or bond paper, and the whole shall be suitably bound and a copy deposited in the library of the University. The subject of the thesis is required to be reported to the head of the department in which the student is a candidate for a degree, and the work of preparation must be formally begun early in the senior year. During the second semester the student is expected to devote at least ten hours a week to the preparation of his thesis.

The subject of the thesis and character of the work to be done upon it will be suggested in a large measure by the course of study pursued by the student. Great emphasis is laid upon the careful and accurate preparation of the thesis; because, more than any other work the undergraduate does, this certifies to his ability to undertake the difficult and responsible duties involved in the direction of engineering and industrial interests. The thesis must be completed and put in the hands of the faculty as early as the senior examination week of the second semester.

COURSE IN SCIENCE AND TECHNOLOGY.

It is very desirable that engineering students taking one of the courses leading to the professional degree, civil engineer, mechanical engineer, or electrical engineer, should have a more liberal education than can now be obtained in the regular four years' course. This has led to the establishment of a five years' course in science and technology in which a student

in the college of engineering may obtain more English and general culture studies, as well as more extended work in the technical sciences, than has been offered heretofore. This course does not diminish in any way the regular courses in engineering—the work is merely distributed over a more extended period. Every subject now included in any one of the regular engineering courses is also included in the corresponding five years' course, and in addition to these there is the equivalent of one year's work in more general subjects.

At the end of the fourth year the degree, bachelor of science in engineering, is conferred. The professional degree, civil engineer, mechanical engineer, or electrical engineer, is granted upon the completion of the fifth year, provided the choice of electives throughout the course has satisfied the requirements of the proposed engineering degree.

FRESHMAN YEAR.

Engineering mathematics [5]
English [4]
French or German [3 or 5]
Chemistry or history [3]
Military drill [2]

SOPHOMORE YEAR.

Engineering mathematics [5]
History, chemistry, French, German or English [3]
Physics [6]
Engineering drawing [4-5]
Rhetoric [1]
Military drill [2]

JUNIOR YEAR.

FIRST SEMESTER.	SECOND SEMESTER.
Mechanics [5]	Mechanics [5]
Physics [3]	Engineering drawing [2]
Engineering drawing [3]	Technical work [5]
Technical work [4]	Elective [7]
Elective [4]	

SENIOR YEAR.

Technical work [4]	Technical work [5]
Technical work [4]	Technical work [3]
Elective [4]	Elective [4]
Elective [4]	Elective [4]
Elective [4]	Elective [4]

POST SENIOR YEAR.

The work of the post senior year is entirely elective and consists of twenty exercises or recitations per week, selected from the following list. The only limitation imposed is that subjects cannot be chosen unless the work leading up to and preparing for such subjects has been completed.

The following electives are offered:

In science:— Chemistry, physics, geology, mineralogy, astronomy and mathematics.

In technology:— Shop practice, engineering laboratory, drawing, design, specifications, measurement and transmission of power, steam boilers, railway engineering, shop economics, water supply engineering, sanitary and municipal engineering, bridge engineering, surveying, alternating currents, telephony and telegraphy, electric light, plant operation, central stations.

In literature and the arts:— English, French, German, history, political science and logic.

The subjects required for the completion of the five years' course will depend upon the particular professional degree desired. Thus for the course in science and technology leading to the degree bachelor of science at the end of four years, and the professional degree at the end of the fifth year, the electives would be selected as follows:

FRESHMAN YEAR.

Mathematics [5]
English [4]
French or German [3 or 5]
Chemistry or history [3]
Military drill [2]

SOPHOMORE YEAR.

Mathematics [5]
History or chemistry [3] (one year of chemistry is required)
Physics [6]
Engineering drawing [4-5]
Rhetoric [1]
Military drill [2]

COURSES IN SCIENCE AND TECHNOLOGY.

JUNIOR YEAR, FIRST SEMESTER.

CIVIL ENGINEERING.	MECHANICAL ENGINEERING.	ELECTRICAL ENGINEERING.
Mechanics, 5.	Mechanics, 5.	Mechanics, 5.
Physics, 6.	Physics, 6.	Physics, 6.
Engineering drawing, 3.	Engineering drawing, 3.	Engineering drawing, 3.
Technological chemistry, 3.	Technological chemistry, 3.	Technological chemistry, 3.
Topographical, 4½.	Shop practice, 4½.	Shop practice, 4½.
	Stresses, 2.	Dynamos and motors, 2.
		Stresses, 2.

SECOND SEMESTER.

Mechanics, 5.	Mechanics, 5.	Mechanics, 5.
Engineering drawing, 2.	Engineering drawing, 2.	Engineering drawing, 2.
Topography, 4½.	Dynamos and motors, 4.	Dynamos and motors, 4.
Highways, 2.	Electric laboratory, 3.	Electrical laboratory, 3.
Practical astronomy, 2.	Mechanism, 2.	Mechanism, 2.

SENIOR YEAR, FIRST SEMESTER.

Water supply, 2.	Thermodynamics, 3.	Thermodynamics, 3.
Curves and earthworks, 2.	Prime movers, 2.	Prime movers, 2.
Machine design, 2.	Machine design, 4.	Machine design, 4.
Stresses, 3.	Mechanical laboratory, 2.	Mechanical laboratory, 2.
Least squares, 2.	Shop practice, 10.	Shop practice, 10.
Mechanical laboratory, 2.		
Electric power, 3.		

SECOND SEMESTER.

Stresses, 3.
Structural details, 3.
Railway work, 3.
Sanitary engineering, 3.
Geology, 3.
Elective, 4.

Steam engines, 3.
Mechanical laboratory, 2.
Machine design, 4.
Thermodynamics, 3.
Shop practice, 10.

Steam engines, 3.
Mechanical laboratory, 2.
Machine design, 2.
Electrical design, 2.
Elective, 4.
Shop practice, 10.

POST SENIOR YEAR, FIRST SEMESTER.

CIVIL ENGINEERING.

Masonry, 3.
Structural design, 5.
Experimental laboratory, 2.
Railway economics, 2.
Political science, 2.
Elective, 6.

MECHANICAL ENGINEERING.

Machine or railway design, 4.
Mechanical engineering, 2.
Mechanical laboratory, 2.
Political science, 2.
Elective, 8.
Thesis.

ELECTRICAL ENGINEERING.

Alternating currents, 3.
Electrical engineering, 4.
Electrical laboratory, 2.
Mechanical laboratory, 2.
Political science, 2.
Elective, 6.
Thesis.

SECOND SEMESTER.

Structural design, 5.
Arches, 2.
Geodesy, 3.
Political science, 2.
Elective, 2.
Contracts and specifications, 2.
Thesis, 4.

Contracts and specifications, 2.
Machine or railway design, 4.
Mechanical laboratory, 4.
Political science, 2.
Elective, 4.
Thesis, 4.

Contracts and specifications, 2.
Electrical design, 3.
Electrical laboratory, 2.
Electrical engineering, 4.
Political science, 2.
Elective, 2.
Thesis, 4.

As the strictly professional courses offer little opportunity for specialization in the physical and technical sciences, and the liberal culture studies are necessarily very limited in such courses, the general course in science and technology affords an opportunity for more extended work in physics, chemistry and other sciences, together with additional studies in English, history, political science and similar subjects.

While the choice of electives in the general course in science and technology is very liberal there is necessarily less freedom in the selection of subjects in those courses which lead to the engineering degrees.

For the first two years no electives are offered and the work is common to the general and the five years' professional courses.

While the student is allowed to make his own selection of electives in the general course, subject to known requirements, the following is suggested as a representative non-professional technical course leading to the degree, bachelor of science in engineering, at the end of four years:

A FOUR YEARS' GENERAL COURSE IN SCIENCE AND TECHNOLOGY.

FRESHMAN YEAR.

Mathematics [5]
English [4]
French or German [4]
Chemistry or history [4]
Military drill [2]

SOPHOMORE YEAR.

Mathematics [5]
History, chemistry or language [4]
Physics [4]
Engineering drawing [4]
Rhetoric [1]
Military drill [2]

JUNIOR YEAR.

FIRST SEMESTER.

Mechanics [5]
Physics [4]
Engineering drawing [4]
Technological chemistry [2]
Chemistry [4]

SECOND SEMESTER.

Mechanics [5]
Physics [3]
Engineering drawing [4]
Mechanism [3]
or surveying [3]
Chemistry [4]
Mechanical laboratory [2]

SENIOR YEAR.

Thermodynamics [3]
or mineralogy [4]
Industrial electricity [3]
or electric power [3]
Physics [4]
Political science [4]
Elective [4]

Dynamos and motors [3]
Thermodynamics [3]
or geology [4]
Steam engine [2]
or highways [2]
Physics [4]
Political science [4]
Elective [4]

The required subjects are printed in Roman type; the electives, printed in italics, may be replaced by others selected from the general list.

Students

SENIOR CLASS, 54.

CIVIL ENGINEERS, 20.

Bisbee, Elmer, Madelia.
Brockway, Roydon Ray, Luverne.
Burke, Roy Latfourette, Minneapolis
Cutter, Alvin S.. Minneapolis.
Feyder, William Henry, St. Paul.
Finley, Joseph Edward, Janesville.
Gillette, George Lewis. Minneapolis
Gregg, T. D., Minneapolis.
Hopeman, Albert M., Preston.
Jensen, John Arthur, Fergus Falls.
Johnson, Nels, Preston.
King, W. Eugene, Anoka.
McMillan, Franklin R., Luverne.
Malloy, Charles James, Red Wing.
Mattison, Oliver, Minneapolis.
Mueller, Henry John, Hamburg.
Nelson, Oscar B.
Schurtz, Darwin, New Ulm.
Smith, Donald Tidd, Chicago, Ill.
West, Robt. W., Minneapolis.

MECHANICAL ENGINEERS, 15.

Andrews, Geo. L., Minneapolis.
Bates, Albert Henry, St. Louis Park.
Clipfell, Carroll D., Minneapolis.
Cutler, Frank, St. Paul.
Gerrish, Harry Eldon, Minneapolis.
Harris, Sigmund, Minneapolis.
Jackson, Earle Daniel, Minneapolis.
Johnson, Austin G., So. Humboldt.
Johnson, Ernst P., Albert Lea.
Jones, Raymond Lasley, Minneapolis.
Lewis, Edward B., Willmar.
Pancratz, Alexander J., Perham.
Rydeen, F. G. A., Gibbon.
Sperry, Leonard Boyd, Wasioja.
Tuck, George Albert, Minneapolis.

ELECTRICAL ENGINEERS, 19.

Adams, William Charles, Minneapolis.
Anderson, Emil, Farwell.
Billau, Lewis Scoville, St. Paul.
Boman, Carl Emmanuel, Cokato.
Coleman, Frank D., Ellendale, N. D.
Davis, Chas. A., Minneapolis.
Ely, Irving Robinson, Milbank, S. D.
Frankoviz, John Joseph, Fergus Falls.
Gibson, Charles B., Minneapolis.
Jackson, E. D., Minneapolis.
Kochendorfer, Milton J., South Park.
Le Blond, Edmond Jean, Minneapolis.
LeTourneau, Edward Harold, Duluth.
Lundquist, Ruben A., Red Wing.
Morris, Robert, Greenleafton.
Ryan, Will, Joice, Iowa.
Simmon, Karl Albert, Jr., St. Paul.
Smith, Clinton Besley, Minneapolis.
Wood, John W., Stewartville.

JUNIOR CLASS, 75.

CIVIL ENGINEERS, 26.

Adams, Elmer Ellsworth, Willmar.
Alrick, Bannona Gerhardt, Zumbrota.
Alsop, Ernest Benbon, Minneapolis.
Batson, Charles Drewry, Bald Eagle Lake.
Childs, Donald, Ortonville.
Childs, Hervey Butler, Ortonville.
Childs, John C., Minneapolis.
Cram, Clyde M., Zumbrota.
Dougan, Henry Knox, Minneapolis.
Dunham, John A., Mason City, Iowa.
Hanauer, Monroe, St. Paul.
Hawley, Harry Garfield, Worthington.
Hayward, Geo. I., Pine Island.
Hobart, Walter Beal, Minneapolis.
Livingston, Robt. W., Fairmont.
Murphy, John, Litchfield.
Okes, Day Ira, Minneapolis.
Ostvig, Richter N., Benson.
Peterson, Arthur Andrew, St. Paul.
Reed, Arthur Lathrop, Minneapolis.
Root, Alex B., Minneapolis.
Thomas, Evan, Lake Crystal.
Tondel, Mandel George, Minneapolis.
Widell, Gust Fred, Mankato.
Wiesner, Frederick Edward, Tracy.
Woolery, Mark, Blue Earth.

MECHANICAL ENGINEERS, 11.

Armstrong, Thos. S., Minneapolis.
Crawford, Wallace Tyler, Faribault.
Krag, Clarence W., Hampton, Ia.
Loye, Benj. W., Red Wing.
Miller, Leslie Freeland, Minneapolis.
Mitchell, Henry Z., St. Cloud.
Morse, Gordon V., Sauk Center.
Rawson, Ralph Harvey, Faribault.
Ringsred, Arthur Christian, Duluth.
Rose, Norman, Duluth.
Wiley, Guy E., Steele, N. D.

ELECTRICAL ENGINEERS, 37.

Albrecht, George Moritz, St. Paul.
Allen, Elmer Augustus, Lanesboro.
Anderson, Godfrey, Lake City.
Bunce, Paul Fay, Minneapolis.
Burwell, Loring Dunham, Minneapolis.
Calmeyer, John Peter, Glenwood.
Carter, Robert J. S., Austin.
Cohen, Nathan, Minneapolis.
Cooper, Leo Henry, Minneapolis.
Cornelius, Martin, Roberts, Wis.
Disney, Leonard W., Zumbro Falls.
Dunn, Andrew Paul, Winnebago City.
Evans, Leon Rozelle, Hutchinson.
Fairchild, A. Royal, Minneapolis.
Finchy, Jacob Oscar, Wabasha.
Garber, Gabriel E., Minneapolis.
Gunther, Albert N., St. Paul.
Haeberle, Elmer Harvey, New Ulm.
Harris, Clayton, Minneapolis.
Hoff, Christopher, Jr., St. Paul.
Hokanson, Clarence, Hector.
Hovelson, Henry, Minneapolis.
Hubbard, Robt. T., St. Paul.
Lang, Charles Arthur, Minneapolis.
Payne, Harold Gould, Minneapolis.
Roepke, Otto Bismarck, Minneapolis.
Schow, Wm. P., Minneapolis.
Schwedes, Walter Fred, Wabasha.
Shuck, Gordon R., Rushmore.
Stenger, Lawrence A., Minneapolis.
Stephenson, Oliver, St. Anthony Park.
Stone, Harris G.
Thornton, Edward Burdette, Benson.
Ungerman, Carl Mugg, Waseca.
Weber, Erwin Leo Franz, Helena, Mont.
Wiggins, Gerald Graham, Minneapolis.
Woehler, William Louis, Arlington.
Zimmer, William Arthur, Big Stone City, S. D.

SCIENCE AND TECHNOLOGY, 1.

Anderson, Edward, Minneapolis.

SOPHOMORE CLASS, 97.

CIVIL ENGINEERS, 28.

Ash, J. Wesley, Wendell.
Blomquist, Hjalmer Frederick, Lake City.
Broderick, Geo. H., Minneapolis.
Brueger, Albert Henry, St. Paul.
Dallimore, Arthur Norman, St. Paul.
Dougherty, Joe, Litchfield.
Ellis, Bruce Bonthron, Duluth.
Fleming, Douglas Reed, St. Paul.
Gage, Hugh Newton, Winona.
Grant, James Allen. Windom.
Green, Fred Hall, Rushford.
Haverson, Henry D., Winona.
Hayes, Albert Orion, Minneapolis.
Houck, Stanley Buck, Minneapolis.
Hyatt, Frank L., Minneapolis.
Jones, Lewis Allen, Worthington.
Kelly, Earl Wallace, Aitkin.
Knowlton, Herbert Hamilton, Minneapolis.
Lawrence, Chas. McL., Minneapolis.
Leland, Oscar B., Winona.
Loomis, Leon Elliott, Minneapolis.
Mitchell, John B., Zumbrota.
Olson, Ernest Victor, Welch.
Paris, Clarence Hiram, Winona.
Quinn, John, Minneapolis.
Randall, Heman Ward, State Fair Grounds.
Stinchfield, Mark, Fairmont.
Swenson, Charles August, Winthrop.

MECHANICAL ENGINEERS, 31.

Baer, Louis E., Kenyon.
Beckjord, Jesse G., St. Paul.
Bell, Maurice Dwight, Minneapolis.
Birnberg, Henry Herman, St. Paul.
Bjorge, Oscar Bernard, Underwood.
Bogart, Jay Vander, Zumbrota.
Boyce, Leonard F., Minnneapolis.
Buhl, Paul Stephens, Graceville.
Cox, Richard Ferguson, Graceville.
Ellison, Jay T., St. Paul.
Elston, Fred C., Minneapolis.
Fee, E. Frank, Duluth.
Geraghty, Herbert Aloysius, St. Paul.
Gessert, George Richard, St. Paul.
Gilman, Nicholas Albert, St. Cloud.
Hartzell, James H., Minneapolis.
Holcomb, Myron D., St. Paul.
Holmgren, Charles Ernest, Breckenridge.
Larson, Swahn A., Minneapolis.
Lowey, Frank John, Brainerd.
Nicoll, George Ramsey. St. Paul.
Northrup, Edwin Bercele, Minneapolis.
Randall, John R., Minneapolis.
Scofield, Russell Boyd, Winona.
Shepherd, Franklin Moody, Maquoketa, Ia.
Smith, Albert Bicknell, Minneapolis.
Souba, William Henry, Hopkins.
Stacy, Elmer Neil, Eden Prairie.
Trabert, William Henry, Minneapolis.
Tubby, Oliver George, St. Paul.
Wagner, Otto Henry, New Richland, Wis.

ELECTRICAL ENGINEERS, 36

Alton, Herbert Dennett, Ceylon.
Andrus, Raymond J., Mason City.
Bachrach, Alfred, Faribault.
Bergendahl, Harold, Ellendale, N. D.
Borrowman, Leroy, Stillwater.
Brown, Oliver, Minneapolis.
Cotter, Clarence Joseph, Minneapolis.
Countryman, Peter Frederick, Appleton.
Dirimple, George, Jr., Minneapolis.

Doerfler, Julius A., Richfield.
Geil, Harry Festus, Bemidji.
Granzow, Ernest F., Duluth.
Hampson, Henry Oscar, Ada.
Hartney, John James, Maynard.
Hoppin, Glenn, Northfield.
Kerns, Ralph W., Detroit.
Kjelland, Joseph Almon, Rushford.
McAfee, Allan Linsay, St. Paul.
Meany, James, Lake City.
Montgomery, Grant, St. Paul.
Morris, William Bernard, Winona.
Mowry, Harry Wheelock, Minneapolis.
Nekola, John, LaCrosse, Wis.
Norcross, Arthur Floyd, Minneapolis.
Oech, George Fred, Wilson.
Pearce, J. H., St. Paul.
Raetz, Stephen James, Hastings.
Rezab, John Joseph, Winona.
Slade, Charles William, Adrian.
Smith, Byron, E., Minneapolis.
Smithson, John Edward, Hawick.
Spring, Willis Ware, Minneapolis.
Sturtevant, Percy, Detroit.
Thompson, Herbert Leslie, Minneapolis.
Uzzell, George Walter, Minneapolis.
Zimmerman, Louis Peter, Waseca.

SCIENCE AND TECHNOLOGY, 2.

Clarke, Charles P., Elysian.
Councilman, Halstead P., Minneapolis.

FRESHMAN CLASS, 171.

CIVIL ENGINEERS, 46.

Albrecht, Armin, St. Paul.
Alden, Herbert C., Minneapolis.
Arndt, Wm. P., Pine Island.
Bailey, Paul T., Minneapolis.
Banderlin, Wm. J., Arlington.
Barnes, Paul, Minneapolis.
Bland, Guy C., Anoka.
Brenchley, Harry, Minneapolis.
Brown, George J., Minneiska.
Byrnes, George G., Minneapolis.
Chadwick, Earl E., Owatonna.
Comstock, John W., Sioux Falls, S. D.
Drum, Samuel A., Waseca.
Eames, Paul, Morris.
Effertz, Edward P., Norwood.
Esser, Frank F., Ellsworth.
George, David W., Pipestone.
Gilbert, Royce W., Minneapolis.
Godward, Alfred G., Elbow Lake.
Harrison, Randall, St. Cloud.
Houston, Cecil E., Minneapolis.
Ittner, William F., Red Lake Falls.
Kateley, Walter, Dunnell.
Kranch, William L., St. Paul.
Lang, Fred, Austin.
McAllister, Roy I., Minneapolis.
McCall, Harry J., Minneapolis.
McCree, Andrew A., St. Paul.
McGee, William, Minneapolis.
Martin, Vernon B., Minneapolis.
Methven, Clyde, Minneapolis.
Moe, Alfred, Duluth.
Mowery, Clarence W., Northfield.
Norelius, Lewis M., Luverne.
Okes, Sidney R., Minneapolis.
Pancratz, Frank J., Perham.
Paul, F. T., Minneapolis.
Ring, William E., Morris.
Robbins, Raymond Spencer, Red Lodge, Mont.
Robertson, Charles N., Sleepy Eye.
Schlattman, Edward C., Alberta.
Stevens, John C., St. Paul.
Totushek, Arthur J., Silver Lake.
Walter, Otto R., Hector.
Whittier, Albert A., Red Wing.
Willis, Roy, St. Paul.

MECHANICAL ENGINEERS, 41

Anderson, Frank A., Wells.
Barnes, Russell G., Duluth.
Best, Herbert L., Minneapolis.
Bill, Jesse, Northfield.
Bingham, Stanley E., New Ulm.
Bowen, Frank W., Minneapolis.
Buhl, John E., Graceville.
Cook, Harold G., Merriam Park.
Decker, Lyall, Minneapolis.
Dewart, Clement V., Minneapolis.
Ervin, Harry C., St. Cloud.
Estep, Harvey C., Minneapolis.
Fleming, Frank R., St. Paul.
Frary, Hobart D., Minneapolis.
Gaston, Le Roy, Minneapolis.
Gjerberg, Ole H., Red Lake Falls.
Gunderson, Alfred J.,
Pelican Rapids.
Hustad, Byron P., Granite Falls.
King, Robert N., Minneapolis.
Kinnard, Oscar B., Minneapolis.
Lagerstrom, Cornell A.,
Minneapolis.
Larkin, Arthur E., St. Paul.
Lewis, Robert D., St. Paul.
Morris, Thomas C.,
Lime Springs, Ia.
Moyer, Amos F., Montevideo.
Nelson, Edward S., St. Paul.
Nemec, Frank L., Montgomtry.
Norelius, Emil F., Luverne.
Norton, Clyde W., Lisbon, N. D.
Oppenheim, Greve, St. Paul.
Priedeman, George W., St. Paul.
Rahr, Niels, Manitowoc, Wis.
Rebman, Emory C., Pipestone.
Rhodes, William, Jr., St. Paul.
Segall, Julius, St. Paul.
Sperry, James D., Wasioja.
Stone, Raymond T., Morris.
Thompson, Raymond S.,
Monticello.
Waller, Conrad J., St. Paul.
Wilcox, Donald H., Minneapolis.
Wright, Harris H., Farmington.

ELECTRICAL ENGINEERS, 67.

Barnum, George G., Duluth.
Bolton, John B., Minneapolis.
Boyum, Benjamin O., Rushford.
Carmon, Curtis R., Little Falls.
Casberg, James M.,
La Crosse, Wis.
Chandler, Malcolm D.,
Calhoun Place.
Clark, Daniel C., Minneapolis.
Cottingham, George, Jr.,
Helena, Mont.
Dahl, Newell H., Minneota.
Davey, Duwayne, Minneapolis.
Ellis, J. T., Jr., Minneapolis.
Elmer, Herbert H., Minneapolis.
Evans, John L., Duluth.
Evans, Lynn, Caledonia.
Fiske, F. William, Jr., St. Paul.
Fitts, Joel A., Minneapolis.
Frahm, Alfred R., Rochester.
Fruen, Arthur B., Minneapolis.
Furber, Pierce P., Northfield.
Giessler, Paul W., Minneapolis.
Greer, Edward R., Minneapolis.
Guderian, Milton L., Alexandria.
Hetherton, Percival, Minot, N. D.
Hognason, Frank G., Minneota.
Hornebrook, James William,
Tower.
Hull, George E., Harwood, N. D.
Irnberg, Andrew W., Cannon Falls.
Ingraham, Harry A., Minneapolis.
Japs, Barney G., Carver.
Johnston, Cyrus T., St. Paul.
Kaiser, F. J., Wells.
Karn, Merrit J., Winona.
Kellogg, Paul M., Red Wing.
King, Alfred B., Welcome.
King, Clarke G., Owatonna.
Kreitter, Arthur L., Duluth.
Magelson, Byron, Minneapolis.
Marsh, Fayette, Stillwater.
Meyer, George R., Hastings.
Michaelson, Joseph M., Perham.
Mooney, Stanton G., Minneapolis.
Ober, Floyd H., Sheldon, Iowa.
Pardee, Harvey S., Minneapolis.
Peterson, Clarence A.,
Blooming Prairie.
Peterson, Henry N., Monticello.

Peterson, James C., Alden.
Preine, Irving A., Minneapolis.
Prentice, Robert S., Minneapolis.
Ranney, James A., St. Cloud.
Sargent, Harry R., St. Paul.
Schlidt, Wm. F. H., Hastings.
Schluter, Ernest A., Hutchinson.
Schoepf, Alfred S., Appleton.
Scobie, Francis G., Duluth.
Simonson, Ernfried T., Minneapolis.
Sitzer, Edward H., St. Paul.
Smith, Alfred N., Wheatland, N. D.
Svendson, George, Minneapolis.
Swanstrom, Frank, Lake Park.
Sweningsen, Oliver, Austin.
Swenson, Theodore M., St. Paul.
Thurley, Arthur D., Winona.
Vireen, Nels John, Minneapolis.
Vita, Theodore, Faribault.
Weibler, William M., Belle Plaine.
Widmann, Alfred, St. Paul.
Williams, Ward T., Wheaton.

COURSE NOT SPECIFIED, 10.

Bergonst, Oscar J., Tacoma, Wash.
Clinch, Ralph S., Rush City.
Currie, Neil, Jr., Currie.
Farnam, Franklin C., Minneapolis.
Harwood, Stanley G., Minneapolis.
Longfellow, Dwight W., Minneapolis.
Magney, Gottlieb R., Amery, Wis.
Miller, Walter N., Ada.
Peterson, George T., New Ulm.
Udell, Carl D., Wells.

SCIENCE AND TECHNOLOGY, 4.

Bunce, Elmer W., Minneapolis.
Hokanson, Nels M., Aitkin.
Kelley, Earl F., Aitkin.
Mitchell, Donald F., Minneapolis.

UNCLASSED, 2.

Curtiss, Lindsley B., Minneapolis.
Glasscock, Henry H., Minneapolis.

Appendix A.

The following are sample sets of questions that have been used in the special examination in English, which is required of all students entering the University.

FIRST SET.

I. (15)

Arrange the following words in two columns, putting in the first column words that are in good use, and in the second column words that are not in good use: enthuse, trolley-car, gent, party, (person), disremember, aggravate, elocute, hustle, amateur, typewritten, pantorium, omnibus, photo, cablegram, sales-lady.

II. (15)

Some of the following sentences are faulty in wording or construction. Rewrite them all, correcting the faults, but not changing the correct forms.

1. Do you think I would do it like he does?
2. She is in an awful hurry, for she thinks her bread has raised too much.
3. Would I be old enough to go?
4. Will we lay our hats upon the table?
5. I left it laying here someplace.
6. Seeing me her work was dropped at once.
7. Not a boy in the crowd knew their own name.
8. A succession of accidents have discouraged him.
9. He was more distinguished than all the generals of his time.
10. Don't worry about us taking cold.
11. I expected to have found him.
12. The company blames the accident on the conductor.
13. I am afraid that we will be very early.
14. In some places it rains most every day.
15. They must have laid there all night.

III. (15)

Punctuate and capitalize the following:

1. We played a little at gardening of course and planted tomatoes which the chickens seemed to like for they ate them up as fast as they ripened and we watched with pride the growth of our lawton blackberries which after attaining the most stalwart proportions were still as bitter as the scrubbiest of their savage brethren as for our grapes the frost cut them off in the hour of their triumph
2. our hand-baggage consisted of the following articles luncheon for four a camera a telescope and two rifles

IV. (15)

Write an essay of 150 or 300 words on one of the following subjects:

The Automobile.
My First Day at the University.
The Purpose of the State Fair.
A Summer Garden.
A Pine Forest.
A Wheat Field.

SECOND SET.

I. (15)

Arrange the following words in two columns putting in the first column words that are in good use, in the second column words that are not in good use: omnibus, enthuse, photo, posted (informed), burglarize, kine, auto, veto, gerrymander, ere, pantorium, eclat (brilliant effect), tantalize, trolley-car.

II. (15)

Some of the following sentences are faulty in construction, or contain examples of incorrect grammar. Rewrite them all correcting the faults, but not changing the correct forms:

1. Each of the ladies were perfect in their parts.
2. The bell had rang before you came in.
3. This book is different than the one I have.
4. She said she should be liable to find her purse there.
5. You know as well as me that the bread hasn't raised.
6. Who did you say would go?

7. He intended to have gone yesterday.
8. The party you spoke to said he would not be able to go.
9. If you and me pull together we will be able to lift it.
10. Us boys were awful glad to go ashore.
11. She spoke to William and me.
12. Did you say you seen him laying on the floor?
13. Stepping on the chair her pitcher fell off her head.
14. That pie looks awful good. Can't I have a piece?
15. I will be very pleased to accept your splendid offer.

III. (15)

Punctuate and capitalize the following:

one dory was smashed to pieces and the sea pitched the man head foremost on the decks cutting his forehead open and about dawn when the racing seas glimmered white all along their cold edges another man blue and ghastly crawled in with a broken hand asking news of his brother seven extra mouths sat down to breakfast a swede a chatham skipper a boy from hancock maine one duxbury and three provincetown men.

IV. (15)

Write an essay of 150 or 300 words on one of the following subjects:

The Automobile.
My First Day at the University.
The Purpose of the State Fair.
A Summer Garden
A Pine Forest.
A Wheat Field.

Note.—The papers will be graded according to their excellence in the following respects: appearance of the paper, hand-writing, spelling, expression, and knowledge of the subject.